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THE RUSSIAN NON-CHERNOZEM WHEAT BASE¹

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THE publicity surrounding recent attempts to expand crop production in the Soviet Union, such as the ploughing of virgin and idle lands in the eastern regions of the country, the sowing of corn for livestock in seemingly almost all parts of the cultivated area, and the development of irrigation in the moisture-deficient regions of the south, should not be permitted to obscure the efforts which the Soviet regime has made over the past quarter of a century to create a commercial wheat base in the non-chernozem or podsolch soil zone of European Russia.

Until the early 1930's when the drive to expand the cultivation of wheat in that part of the union began, the non-chernozem zone had never been an important producer of wheat. Prior to World War I, in an area where the total land in crops amounted to somewhat less than 50 million acres, that sown to wheat represented less than a million acres. Indeed, in peasant agriculture, rye, oats, and barley were the standard grains, with potatoes and flax contributing to the general pattern of land utilization. Throughout the decade following the Bolshevik Revolution, some years showed an increase in wheat acreage above that of the pre-revolutionary period, but there was no strong upward trend. Certainly, in 1928, on the eve of collectivization, the non-chernozem zone with its large

and expanding cities relied almost entirely on imports from the wheat-producing steppe regions to the south and southeast.²

The Stalinist goal, the building of socialism in one country through the erection of a mighty industrial fortress, required that bread be made available to the workers attracted to the cities that would mushroom in the future. Consequently, the decision was shortly thereafter made that a commercial wheat base be established in the non-chernozem zone. This was designed to increase the supply of white bread (in preference to rye or black bread) to the cities of the Central Industrial Region, and would lessen dependence on, and length of haul from, other regions of the country.³

Such a drive would inevitably arouse peasant opposition; in part because it would run counter to traditional peasant attitudes and experience, but also because, as an outcome of collectivization, it would constitute along with other controls immediate state direction

² By 1928, the chief source of wheat for the non-chernozem zone was the South, including the Ukraine, North Caucasus and Crimea. The Volga Basin was of secondary importance, as were the Asiatic regions. The latter, however, had become more important during the mid-1920's. The central chernozem zone supplied only small quantities. See: Vladimir P. Timoshenko, *Agricultural Russia and the Wheat Problem* (Stanford: Stanford University Press, 1932), pp. 468-9.

³ Timoshenko points out that during the mid-1920's the sources of supply for the cities, particularly of the non-chernozem, were very unstable. In 1928-29, for example, the South had practically no surpluses of wheat (in part due to climatic conditions) and the Asiatic regions provided about 60 percent of the total. Thus, the length of haul of grain stuffs, and of wheat in particular, by the end of the decade had increased substantially. *Ibid.*, p. 429.

¹ Research on this topic was undertaken in the summer of 1957 supported by a grant for Slavic and East European Studies from the Social Science Research Council. The manuscript was completed while the author was on leave during the autumn quarter, 1958, as a Research Fellow at the Harvard Russian Research Center, the facilities of which are gratefully acknowledged.



FIGURE 1. 1913

TABLE 1.—TOTAL CROP, GRAIN, AND WHEAT ACREAGES IN THE NON-CHERNOZEM ZONE FOR SELECTED YEARS (in millions of acres)

Year	Total crop sown	Grain	Wheat	Wheat as a percent of all grain sown	Grain as a percent of total crop sown
1913 ¹	32.6 (50.2)	25.6 (43.5)	.7 (1.0)	2.8 (2.1)	78.3 (86.2)
1926 ²	55.8	44.7	1.0	2.3	80.4
1928	56.8	44.5	.9	2.0	76.9
1930 ³	61.3	45.7	1.1	2.3	74.5
1932	64.0	44.7	1.6	3.4	69.4
1934	67.4	46.5	4.4	9.4	71.7
1937 ⁴	66.0	47.0	7.2	15.3	71.0
1938	66.0	45.0	7.4	16.5	68.4
1940 ⁵	65.2	44.7	6.4	14.3	68.5
1950 ⁶	60.8	41.8	4.8	11.4	68.7
1952	62.3	43.2	6.8	15.5	67.4
1954	63.0	43.5	9.2	21.2	69.0
1956	64.7	38.0	6.7	17.5	59.0

¹ *Se'skoe Khoziaistvo Rossii v XX Veke*. Sbornik statistiko-ekonomicheskikh svendenii za 1901-1922 gg. (Moscow, 1923), pp. 78-89. The second set of data are from *Narodnoe Khoziaistvo RSFSR*. Statisticheskii sbornik (Moscow, 1957), pp. 165-70. The first set of data are for districts which existed as of 1913 and thus are not comparable with the latter set which are based on districts as constituted in 1956.

² *Statisticheskii Spravochnik SSSR za 1928* (Moscow, 1929), pp. 160, 178-79, 186-87.

³ *Sotsialisticheskoe Stroitel'stvo SSSR*: Statisticheskii ezhegodnik (Moscow, 1935), pp. 334-37, 342-45.

⁴ *Posevnye Ploshchadi SSSR 1938 g.* Statisticheskii spravochnik (Moscow and Leningrad, 1939), pp. 41, 43, 53, 74.

⁵ *Narodnoe Khoziaistvo RSFSR*, pp. 165-70.

⁶ *Posevnye Ploshchadi SSSR*. Statisticheskii sbornik (2 vols., Moscow, 1957), Vol. 1, pp. 174-82, 200-08, 274-82, 338-46.

of land utilization. Wheat had not been grown extensively in the non-chernozem zone in the past simply because the peasants had not found it profitable under prevailing soil and climatic conditions. Much better adapted to the wet, acid soils and cool summers of the zone was hardy winter rye, the staple grain of the northern and northeastern European plain. The attempt to introduce wheat culture widely into the non-chernozem zone would, therefore, to some extent negate the idea of regional specialization, which requires that crops and livestock be raised in areas where conditions are more favorable, making the activities most economical.⁴

AREA OF STUDY

In order to permit a better understanding

⁴ The XVIth Party Congress in 1930 charged the Lenin All-Union Academy of Agricultural Sciences to examine the question of the rational distribution of crops and branches of agricultural activity, involving the substitution of less profitable crops for more profitable crops, assuring the USSR of the possibility of a sufficient supply of the basic food and technical crops, etc., etc. Certainly, in view of the supply of lime and fertilizers available to the farms of the non-chernozem zone, the attempt made within a few years to expand significantly the acreage in wheat would seem to contradict the directive of the Party. Balzak, writing at the end of the 1930's, nevertheless cites

of the history and nature of the Soviet drive to create a commercial wheat base in the non-chernozem zone, the present study has been restricted to an area embracing 19 oblasts and 7 autonomous republics in the central and northern part of European Russia (Fig. 1). These provinces were selected on the basis of available and workable data. Excluded from consideration were the Baltic Republics, Belorussia, and the non-chernozem oblasts of the Urals, since administrative boundary changes with respect to those territories have made the pertinent data difficult to assess and correlate with any exactitude over a period of time. Northern Siberia did not figure to any extent in the program and therefore has not been included. Nevertheless, the area thus delimited for the purposes of this study constitutes

examples of progress in this task: the increase in the area in grain crops in the eastern and non-chernozem regions; the spread of wheat northward; the creation of new cotton and sugar-beet regions, etc. S. S. Balzak, V. F. Vasyutin, and Ya. G. Feigin, *Economic Geography of the USSR* (New York, 1950), p. 355. However, according to Obolenskii, the Academy "did not fulfill its important task . . ." and "for many years entirely ignored the introduction of economic considerations into agriculture." K. P. Obolenskii, "Problema ratsional'nogo razmeshcheniia i spetsializatsii sel'skogo khoziaistva v SSSR," in *Voprosy Razmeshcheniia i Spetsializatsii Sel'skogo Khoziaistva* (Moscow, 1957), p. 23.

the bulk of the European Russian non-chernozem zone.

THE DRIVE FOR A WHEAT BASE

Although the First Five Year Plan (1928-32) and the collective re-organization of agriculture that accompanied it brought an increase in wheat acreage (Table 1), the concerted drive for a northern wheat base began officially with the Second Five Year Plan (1933-37).⁵ Surveys and studies of northern climatic and soil conditions were organized and carried out in the summer of 1933,⁶ and ambitious goals for sowing wheat were established. It was proposed to expand acreage during the plan period by more than seven times, raising the total area under wheat in the zone to more than ten million. By 1937, therefore, the wheat acreage of the non-chernozem zone would represent about ten percent of the total Soviet wheat area. Indeed, the non-chernozem zone was to become, if goals were fulfilled, a secondary producer of wheat, a development which would involve a marked change both in the traditional position of wheat among other northern grains as well as in the relationship of the non-chernozem zone to other regions of the country in marketability of wheat.

Much of the planned increase in acreage was to be achieved through the cultivation of virgin and little-used land, the reported estimates of which were considerable (Table 2). In fact at the XVIIth Party Congress in 1934, where the plan to create "a steady wheat base in the central and northern regions" of European Russia was reaffirmed,⁷ Stalin indicated that about 12 million acres of virgin bush land in the non-chernozem zone could be utilized immediately for wheat.⁸ Thus, the initial drive to expand the sowing of wheat in the north was intended to come not at the expense of other agricultural land uses, but rather through the occupation of new land. The collective farms would continue to grow

TABLE 2.—ESTIMATES OF ARABLE LAND SUITABLE FOR WHEAT IN THE NON-CHERNOZEM ZONE¹
(in millions of acres)

Province	Total area of crop and unimproved land suitable for wheat	Crop land suitable for wheat without liming	Crop land suitable for wheat after liming
Northern Krai	n.d.	1.5	1.0
Leningrad Oblast	14.8	2.4	1.2
Western Oblast	11.9	2.7	2.1
Moscow Oblast	22.9	8.6	2.0
Ivanovo Oblast	12.1	1.9	1.5
Gorki Oblast	24.2	11.0	1.7
Tatar ASSR	15.6	7.7	n.d.
Total	101.5	35.8	9.5

¹ *Severnaya Pshenichnaya Baza SSSR* (Leningrad, 1934), p. 68.

rye and other traditional crops, but in addition they would assimilate new land for wheat.

By 1937, to all outward appearances, considerable progress had been made (Table 1, Fig. 2). Within the study area, the planting of wheat had grown to more than seven million acres, with wheat constituting about 15 percent of all grains sown. However, in spite of Stalin's statement at the XVIIth Party Congress, the increase in wheat came not so much through the use of virgin land; rather, wheat was sown on pasture and meadow lands requiring little initial investment.⁹ To some extent also, wheat replaced winter rye and oats. While the prewar edition of the Soviet agricultural encyclopedia revealed that more than six million acres of land had been reclaimed in the non-chernozem zone from 1933 to 1936,¹⁰ it seems doubtful that such land contributed significantly to the increase in the wheat area. Actually, the total sown area of the non-chernozem zone increased during the Second Five Year Plan by only two million acres, thus falling far short of the original goal. Nevertheless, it was this dramatic expansion in wheat acreage that led Balzak, Vasyutin and Feigin to state in their prewar *Economic Geography of the USSR* that "a new wheat base has been created in the non-chernozem zone . . . a reliable wheat base which provides the country with supplement-

⁵ *Vtoroi Platiletnii Plan Razvitiia Narodnogo Khoziaistva SSSR (1933-1937 gg.)* (Moscow, 1934), pp. 15-81; *Severnaya Pshenichnaya Baza SSSR* (Leningrad, 1934), p. 3.

⁶ *Pochvovedenie*, 1934, No. 2, p. 265.

⁷ A. K. Shevliagin, *Kultura Iarovoi Pshenitsy na Severo-Vostoke* (Moscow, 1953), p. 5.

⁸ V. E. Pisarev, "Iarovaia pshenitsa v nechernozemnoi polose," *Sovetskaya Agronomiia*, 1948, No. 5, p. 42.

⁹ "Soviet Agricultural Reorganization and the Bread-Grain Situation," in *Wheat Studies of the Food Research Institute*, Vol. XIII, No. 7 (April, 1937), pp. 340-41.

¹⁰ *Se'skokhoziaistvennaia Entsiklopediia* (2nd ed., 4 vols.; Moscow and Leningrad, 1937-1940), Vol. 4, p. 490.

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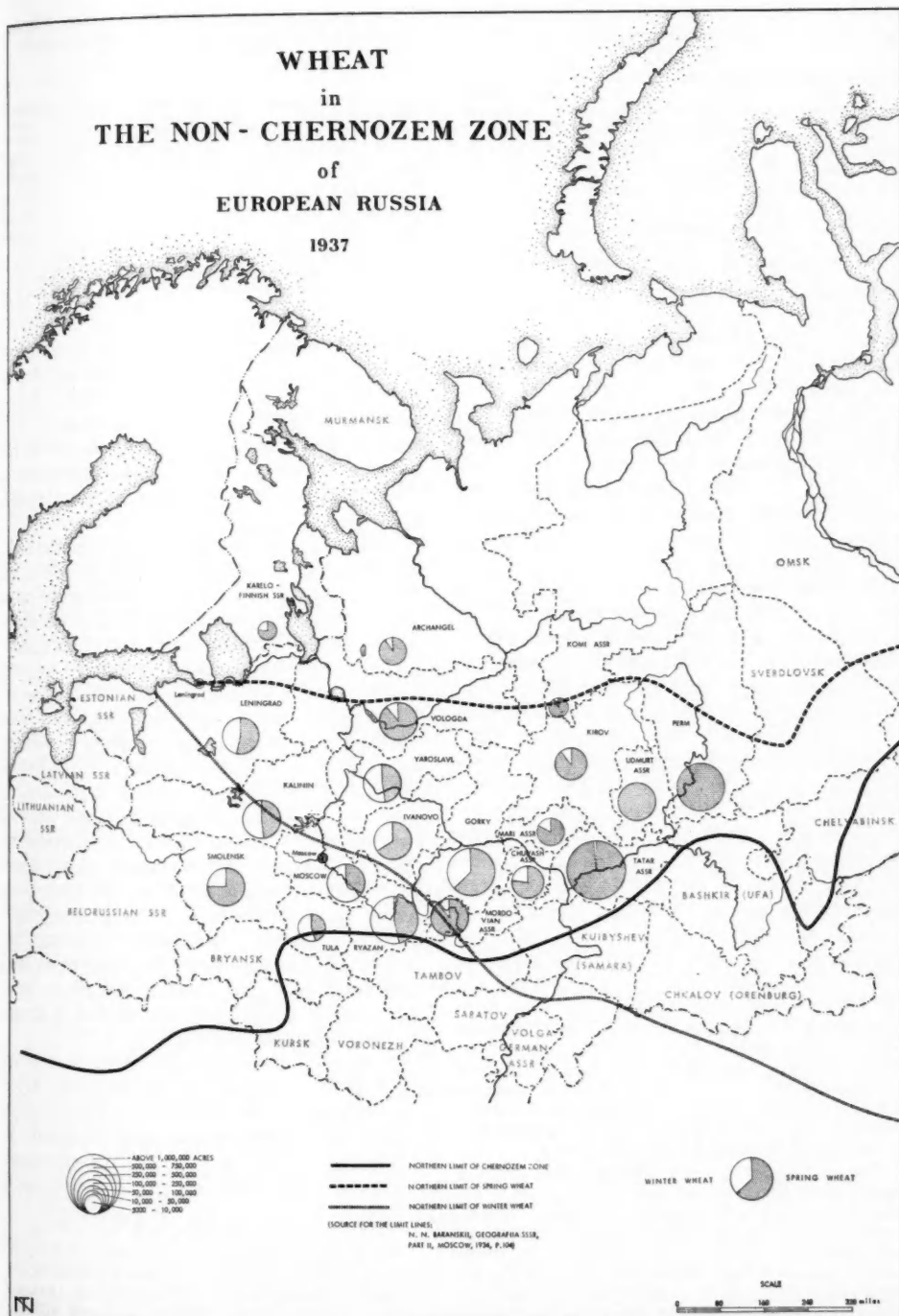


FIGURE 2. 1937

TABLE 3.—CHANGES IN WHEAT ACREAGE FOR GIVEN PROVINCES IN THE NON-CHERNOZEM ZONE, 1937–40 (in acres)

Province	1937 ¹	1938	1940 ²
Gorki Oblast	609,600	663,700 ¹ –651,800 ²	504,100
Kirov Oblast	279,500	301,700	298,500
Leningrad Oblast	444,300	384,700	–375,800
Moscow Oblast	345,400	310,400	–262,700

¹ *Posvnyye Ploshchadi SSSR 1938 g.*, pp. 53, 74.

² Naum Jasny, *The Socialized Agriculture of the USSR* (Stanford: Stanford University Press, 1949), p. 724, quoting S. F. Demidov, in *Socialist Agriculture* (Sotsialisticheskoe Zemledelie), 1942, No. 2, p. 21.

tary resources of commercial grain to meet the needs of the cities of the Central Industrial Region. . . .¹¹

The upward trend in wheat acreage continued in some non-chernozem oblasts into 1938 but thereafter came to a general halt (Tables 1, 3). The Third Five Year Plan (1938–42) had directed the kolkhozy in the non-chernozem zone to assimilate six million acres of virgin land. However, no major increase in the wheat area was called for.¹² On the other hand, the regime relaxed its drive and offered, by the decree of December 28, 1939, some choice to the collective farmers as to the grains they were to grow; those in the non-chernozem zone responded by returning to traditional crops.¹³ The approach of World War II may have dictated concessions to the collective farms. In the non-chernozem zone, however, serious difficulties must have become readily apparent as a result of the relentless drive for wheat in the mid-30's. In the haste to reach the goals assigned, sound agronomic practices, including the introduction and maintenance of proper crop rotations, were largely ignored. At the same time, the

¹¹ Balzak, *op. cit.*, p. 374.

¹² *Tretii Piatiletний Plan Razvitiia Narodnogo Khoziaistva Sotuzna SSR (1938–42 gg.)* (Moscow, 1939), p. 70. By 1941, ameliorative work had been carried out on some three million acres of virgin land, but much of this land served to strengthen the feeding of livestock. See: *Sel'skokhoziaistvennyye Melioratsii v Nechernozemnoi Polose* (Leningrad, 1949), p. 12.

¹³ Pages 723–24 of Jasny cited in Table 3, fn. 2. Jasny writes that the kolkhozy replaced with oats part of the spring wheat planned for them, and with winter rye part of the planned winter wheat, although in this action they were handicapped by the obligation to deliver to the government all of the wheat required of them in the 1940 delivery plan, and wheat was not replaceable by any other crop in obligatory deliveries to the government.

TABLE 4.—WARTIME DECLINE IN SPRING WHEAT ACREAGES ON KOLKHOZES FOR GIVEN PROVINCES IN THE NON-CHERNOZEM ZONE¹ (in acres)

Provinces	1940	1946
Veliki Luki Oblast	66,500	14,800
Mari ASSR	74,100	39,500
Yaroslavl Oblast	126,000	81,500
Moscow Oblast	150,000	89,000
Tatar ASSR	1,499,900	894,500

¹ I. Benediktov, "Za moshchnyi pod'em zernovogo khoziaista," *Sotsialisticheskoe Sel'skoe Khoziaistvo*, 1947, No. 2, p. 12.

reduction in pasture land and, to some extent, in feed grains, could not but have an adverse effect on livestock-raising already reeling under the impact of collectivization. Reflecting the response to the change in policy, the sowing of wheat in the non-chernozem in 1940 declined to scarcely more than six million acres.

During the war, when part of the non-chernozem zone, i.e., to the west of Moscow, fell to invading German armies, the cultivation of wheat continued to decline (Table 4), reaching by the end of the conflict probably about half of the seven million acres sown in 1938.

The immediate postwar period saw the Soviet regime again turn its attention to the northern wheat base in an effort to recover the losses endured during the war. In February, 1947, the Plenary Session of the Central Committee of the Communist Party directed the collective farms in the non-chernozem zone to increase the sowing of spring wheat by 500,000 acres and raise by 1948 total spring wheat acreage to more than four million.¹⁴ Moreover, since much land, including that reclaimed during the 1930's, had gone back into bush and had been unattended during the war, it was recommended that it be put immediately into use.¹⁵

Recovery, however, was slow. It was not until 1950, and particularly after the XIXth Party Congress in 1952, that a significant increase in wheat acreage again occurred. By 1954, the wheat base in the non-chernozem consisted of 9.2 million acres, a record year in

¹⁴ Pisarev, *op. cit.*, p. 43.

¹⁵ *Sel'skokhoziaistvennyye Melioratsii v Nechernozemnoi Polose*, p. 14; A. G. Trutnev, *Obrabotka Tselinnykh i Zaleznykh Zemel'* (Moscow and Leningrad, 1954), p. 55. The use of such land was still being recommended as late as 1954.

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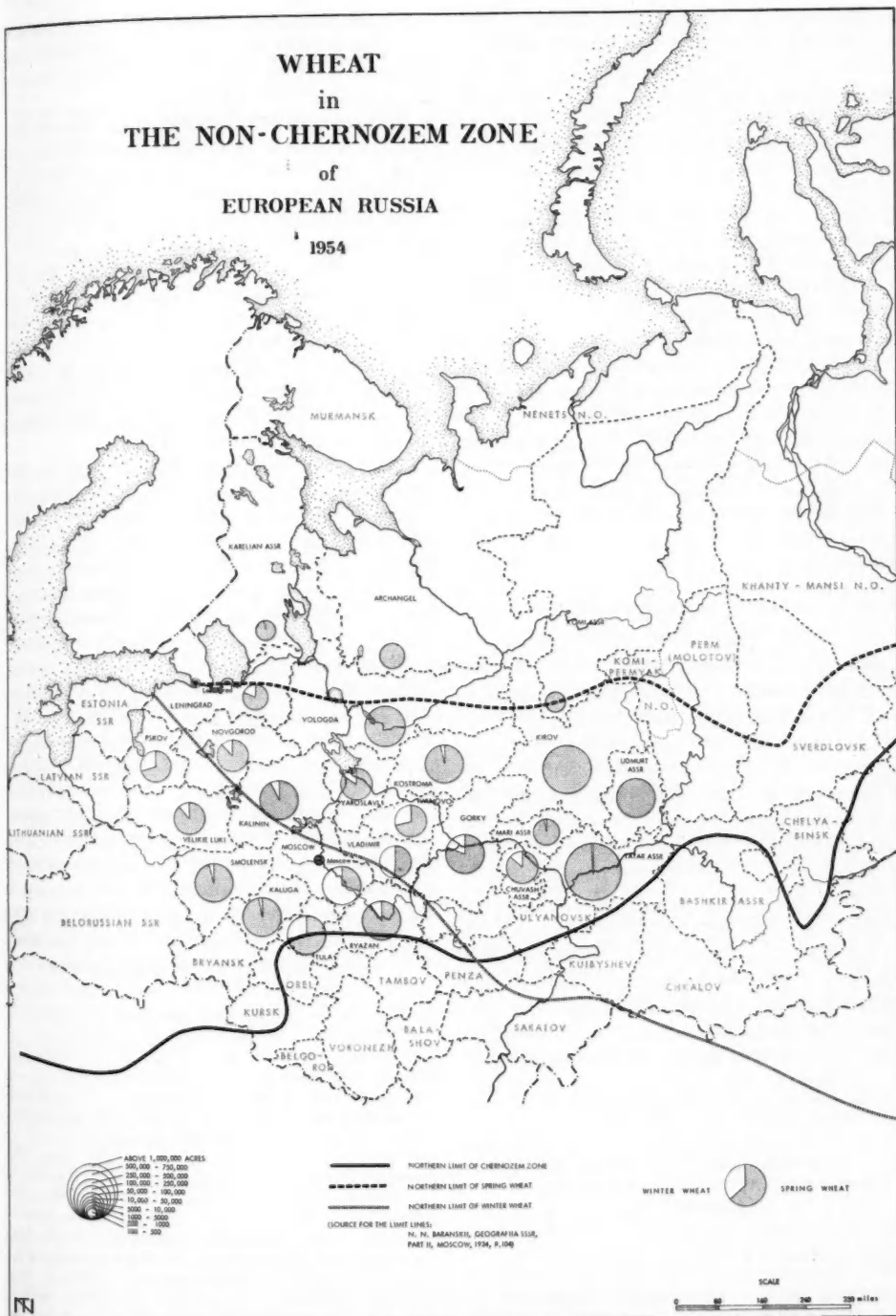


FIGURE 3. 1954

acreage, and this represented about 21 percent of the grain area compared with 15 percent in 1937-38 (Table 1, Fig. 3). Since the area in grains grew by only 1.7 million acres from 1950 to 1954, the 4.4 million-acre wheat increase during the same period was achieved largely at the expense of other crops, notably rye and oats.¹⁶

However, in 1955 decline set in again. The remarkable expansion in wheat acreage resulting from the ploughing of virgin and idle lands in the eastern regions of the country undoubtedly had repercussions on the non-chernozem wheat base.¹⁷ At the same time, the persistent problems associated with wheat culture in the non-chernozem zone may also have again dictated a shift in emphasis, as in the latter part of the 1930's. Nevertheless, by 1956, the sowing of wheat in the non-chernozem had fallen below the 1937-38 level, although wheat continued to constitute a much larger portion of the grain sown than in the prewar years.

THE PROBLEMS OF WHEAT CULTURE IN THE NON-CHERNOZEM ZONE

Although the Soviet regime has claimed that it has been successful in pushing the limits of wheat cultivation northward far beyond that achieved before the revolution,¹⁸ the non-chernozem wheat base involves essentially the southern part of the zone, roughly south and southeast of Leningrad. In European Russia, the northern limit of steady wheat cultivation marches closely with the 60th parallel east of the latter city, but dips southward to the neighborhood of Perm (Molotov) as the Urals are approached. This line represents the thermal limit of wheat which, according to Soviet agronomists, totals about 1600 Centigrade degrees of summer heat (i.e., the sum of the mean daily temperatures for days with aver-

age temperatures above 10° C.).¹⁹ Wheat may be sown farther north, but such fields are essentially oases of cultivation found mainly in protected river valleys.

Southward from Leningrad to Moscow the frost-free season lengthens from 110 to 130 days, and normally is of sufficient duration for wheat to mature.²⁰ Since climatic conditions in winter throughout much of the non-chernozem zone are severe, a large portion of the wheat must be sown in spring. Yet, for spring wheat the danger of an early autumn frost is real, especially if the spring is late and/or delays occur in sowing or in harvesting. On the other hand, not only low winter temperatures but an uneven and unreliable snow cover may present considerable risks in the cultivation of winter wheat.

While total precipitation throughout the non-chernozem zone totals on the average about 20 inches or slightly more, dry periods in spring are not infrequent, especially in Moscow Oblast; and in the provinces along the Volga to the east. The drought, if accompanying late sowing, may significantly retard growth. On the other hand, when summers are cool and damp, the Swedish fly may cause considerable damage. Swedish fly infestations are particularly heavy also in the central chernozem zone to the south.²¹ Because of the prevalence of the fly, losses in yields of spring wheat during the 1930's were considerable, ranging from four to 20 percent of the wheat sown. Indeed, losses have been reported up to 50 percent of the sowings! Largely because of the fly, therefore, spring wheat acreage in the central oblasts of the non-chernozem zone has declined significantly since the early 1930's, and the regime has given considerable

²⁰ V. P. Kuz'min, "Nechernozemnaia polosa," in *Rastenievodstvo SSSR*, Vol. 1, pp. 99-237.

²¹ Pisarev, *op. cit.*, pp. 44-48. The Swedish fly, Pisarev writes, is not only a hindrance to the successful cultivation of spring wheat in the central non-chernozem oblasts, but also to the south, in Ryazan, Tula, Orel and Kursk Oblasts, which fall in part or entirely within the central chernozem zone. The problem is less serious to the east, where the climate is more continental and wheat is sown earlier. Nor does the fly seem to be a problem in the western districts. Spring wheat also suffers periodically from the *Fusarium* blight, which is more pronounced on heavier soils, particularly when spring wheat is sown late as temperatures are rising. See also: *Sel'skokhoziaistvennaia Entsiklopediia* (3rd ed., 5 vols., Moscow, 1949-56), Vol. 5, p. 291.

¹⁶ The decline in rye and oats amounted to nearly three million acres.

¹⁷ W. A. Douglas Jackson, "The Virgin and Idle Lands of Western Siberia and Northern Kazakhstan: A Geographical Appraisal," *Geographical Review*, Vol. XLVI, No. 1 (1956), pp. 1-19.

¹⁸ K. A. Fliksberger, *Pshenitsy* (Moscow and Leningrad, 1935), pp. 160-62.

¹⁹ G. T. Selianinov, "Spetsializatsii sel'skokhoziaistvennykh raionov po klimaticheskomu priznaku," in *Rastenievodstvo SSSR* (2 vols., Leningrad and Moscow, 1933-34), Vol. 1, pp. 1-16.

TABLE 5.—COMPARATIVE LOSSES OF WINTER WHEAT AND WINTER RYE FOR GIVEN DISTRICTS IN THE NON-CHERNOZEM ZONE¹ (percent of total sowings)

District	1926-34		1935-38	
	Winter wheat	Winter rye	Winter wheat	Winter rye
Leningrad Oblast	2.8	2.9	4.4	2.9
Smolensk Oblast	1.8	4.4	3.4	3.4
Kalinin Oblast	4.5	3.2	5.6	1.9
Moscow			10.4	2.4
Corki Oblast	11.8	4.5	2.5	0.6
Kirov			26.3	3.1
Tatar ASSR	16.4	3.2	28.5	6.0

¹ M. Lapin, "Itogi i perspektivy prodvizheniia pshenitsy na sever," *Sotsialisticheskoe Sel'skoe Khoziaistvo*, 1939, No. 6, pp. 70-87. The author also gives losses in hectares for winter wheat and winter rye.

attention to the sowing of winter wheat instead. Because of the unhappy situation with respect to the cultivation of spring wheat throughout parts of the zone, the regime, in its drive to create a wheat base, has made a vigorous attempt to push the limits and extent of winter wheat culture northward.²²

In this endeavor Moscow Oblast has received much of the attention. As a result, 90 percent of the oblast's wheat is fall-sown. However, in 1956 winter wheat totalled only 313,000 acres, approximately 20 percent of all winter wheat sown in the non-chernozem zone. Losses due to winter killing have been high; east of Moscow, where the winters are more severe, losses have been phenomenal.

The western districts of the non-chernozem zone, because of their relatively milder winters, have been described by Soviet writers as offering the best opportunity for expanding the cultivation of winter wheat.²³ However, losses have also been incurred due to late sowing and early autumn frost, or as a result of inadequate snow cover in mid-winter.²⁴

²² E. K. Alainis, "O prodvizhenii ozimoi pshenitsy na sever," *Sotsialisticheskoe Rekonstruktsiia Sel'skogo Khoziaistva*, 1933, No. 6, pp. 90-100; P. F. Sekun, *Ozimaya Pshenitsa v Nechernozemnoi Polose* (Moscow, 1953), p. 119.

²³ *Sel'skoe Khoziaistvo SSSR*, 1935 (Moscow, 1936), p. 37.

²⁴ For a description of the general climatic conditions of the non-chernozem zone, with respect to crop cultivation, see G. T. Selianinov, "Klimaticheskoe raionirovanie SSSR dlia sel'skokhoziaistvennykh tsel'ei," in *Pamiat Akademiika L. S. Berga*, ed. E. L. Pavlovskii (Moscow and Leningrad, 1955), pp. 215-16.

TABLE 6.—SOWN AREAS OF SPRING AND WINTER WHEAT IN THE NON-CHERNOZEM ZONE FOR SELECTED YEARS (1913-56) (in millions of acres)

Year	Spring wheat	Winter wheat	Spring wheat as percent of total wheat
1913 ¹	.6	.1	90.6
1926 ²	.8	.2	79.0
1928	.7	.2	78.2
1930 ³	.8	.3	69.7
1932	1.2	.4	77.0
1934	3.0	1.4	68.0
1937 ⁴	5.0	2.2	69.7
1938	5.0	2.4	67.8
1940	nd	nd	nd
1950 ⁵	4.4	.4	86.7
1952	6.0	.8	88.6
1954	8.0	1.2	86.6
1956	5.3	1.4	78.7

¹ *Sel'skoe Khoziaistvo Rossii v XX Veke*, pp. 78-89.

² Pages 186-89 of source cited in fn. 2, Table 1.

³ Pages 342-45 of source cited in fn. 3, Table 1.

⁴ Pages 53, 74 of source cited in fn. 4, Table 1.

⁵ Pages 274-83, 338-47 of source cited in fn. 6, Table 1.

Winter rye may also succumb, but losses normally are lower than for winter wheat (Table 5). At any rate, in spite of efforts to expand winter wheat in the western districts, about three-fourths of the wheat in Leningrad Oblast is spring-sown, and the situation in adjacent oblasts, as well as in the Baltic Republics, is comparable.

Throughout the non-chernozem as a whole, the ratio between spring and winter wheat may fluctuate markedly from year to year. In 1913, for example, spring wheat constituted about 90 percent of all wheat sown in the non-chernozem zone; in 1937, it was approximately 70 percent; and in 1954, 87 percent (Table 6). Spring wheat, though more demanding on the soil than winter wheat, continues to constitute the bulk of sowings. Winter wheat lacks the hardiness of winter rye, but with survival yields have generally been higher than those for winter rye or spring wheat (Table 7). This factor accounts for much of the rationale behind the continuing effort to expand the sowing of winter wheat in the non-chernozem zone.²⁵

More basic problems confronting the Soviet regime in the non-chernozem zone pertain to the nature and management of the soils. Wheat prefers a well-drained loamy soil, of

²⁵ M. Lapin, "Itogi i perspektivy prodvizheniia pshenitsy na sever," *Sotsialisticheskoe Sel'skoe Khoziaistvo*, 1939, No. 6, p. 73.

TABLE 7.—COMPARATIVE YIELDS OF WINTER WHEAT, SPRING WHEAT, AND WINTER RYE¹ (centners per hectare)

District ²	Winter wheat 1928-35	Spring wheat 1928-35	Winter rye 1928-35
Northern Krai	n.d. 12.3	n.d. 10.3	8.9 12.3
Leningrad Oblast	9.3 10.3	8.3 8.5	8.8 10.5
Kalinin Oblast	10.0 10.6	7.9 9.3	8.7 11.0
Moscow	10.4	9.8	10.0
Western Oblast	8.9 9.5	8.5 9.4	8.3 9.0
Ivanovo Oblast	9:6 12.0	7.5 9.9	8.9 11.3
Yaroslavl	10.1 ³	8.9	11.4
Gorki Oblast	9.1 10.8	7.9 9.9	8.2 11.5
Kirov	8.8	8.9	10.4
Tatar ASSR	n.d. 9.9	n.d. 9.9	7.3 9.9

¹ Pages 74-75 of source cited in fn. 1, Table 5.

² Within administrative districts as of 1935.

³ 1935 only.

neutral reaction. In general, the podsolch soils of central and northern European Russia are noted for their high acidity (pH values range from 6.5 to 4 or less), low organic content, stoniness, and poor drainage.²⁶ Since the territory is vast in extent, considerable variation obviously exists from place to place. Directives of the party and government have, over the past two decades, repeatedly urged the reclamation and use of virgin land as well as improvement of land already cropped or pastured, but there is little evidence to support a contention of substantial progress. Much of the non-chernozem remains in forest or bush. This is essentially true of the taiga of the north-central and northern districts; but even in the south-central and southern districts, anywhere from 10 to 40 percent of the land is wooded.²⁷

A region of relatively recent glaciation, central and northern Russia contains large stretches of poorly drained and marsh land. One of the more extensive areas of wet land, for example, is east of Moscow, in the Meshchora Lowland. It extends over five million acres, primarily in Ryazan, Moscow and Vladimir Oblasts. Special attention was given to

reclamation in the Meshchora at the XIXth Party Congress in 1952 and reclamation is already under way. But, according to all reports, the problems are immense.

In general, in the eastern districts of the non-chernozem zone, drainage improvement is needed on six percent of the plough land and 25 percent of the pastures and meadows. In the western districts, the ratios are approximately 17 percent and 33 percent, respectively.²⁸ As has already been suggested, however, the cultivation of reclaimed land, especially virgin land, tends to trail at some considerable distance the actual process of reclamation, if indeed much of the land is ever cropped.²⁹

As a result of surveys made in 1933, Soviet writers claimed optimistically that more than 100 million acres of land, then either in use or unimproved and unused, could ultimately be sown to wheat (Table 2). Of this, slightly more than a third or some 35 million acres of crop land could be sown to wheat without the need of applications of lime; an additional 10 million acres would be suitable only after liming. Altogether the 45 million acres of potential wheat land were equal in 1933 to about three-fourths of the sown area of the non-chernozem zone, the sown area being only a small fraction of the reputed total available area, some 70 percent of which was in meadows and pasture.³⁰ The remainder of the 100 million-acre fund, approximately 55 million acres, consisting of marshes, bush and forest land, could be sown to wheat only after considerable expenditure for improvement. Undoubtedly the 12 million acres which Stalin indicated at the XVIIth Party Congress were to be reclaimed during the First Five Year Plan represented the more readily assimilable portion of the above land fund. In any one year, of course, only a relatively small part of the fund could be sown to wheat, since consideration had to be given to the maintenance

²⁸ *Ibid.*, p. 109.

²⁹ M. Neznaev, "Ob osvoenii novykh zemel' v nechernozemnoi polose SSSR," *Sotsialisticheskoe Sel'skoe Khoziaistvo*, 1947, No. 12, pp. 52-6. Neznaev states that, in 1946, of 330,000 acres reclaimed in the northern oblasts of the non-chernozem zone, 28 percent remained unused. In Gorki Oblast, of 50,000 acres reclaimed, more than 80 percent remained unused.

³⁰ Ob Uluchshenii Sel'skokhoziaistvennogo Ispol'zovaniia Zemel' . . . , p. 180.

²⁶ Ob Uluchshenii Sel'skokhoziaistvennogo Ispol'zovaniia Zemel' Nechernozemnoi Polosy Evropeiskoi Chasti SSSR, pp. 42-67. Smirnov in his handbook on crops states that wheat requires a neutral or slightly alkaline soil with a pH from 6 to 8. A. I. Smirnov, *Rastenievodstvo* (5th ed.; Moscow, 1952), p. 39.

²⁷ Ob Uluchshenii Sel'skokhoziaistvennogo Ispol'zovaniia Zemel' . . . , pp. 68-9, 72-4.

of correct crop rotations, to pasture and feed stuffs for livestock, and the demand for other grains, vegetables, and industrial crops, such as flax.

The estimate of crop land suitable for wheat without liming seems altogether too generous. A recent Soviet publication reveals that in the non-chernozem zone from 50 to 60 percent of the crop land (which tends to remain at about 65 million acres) normally requires liming, while in some districts the ratio might rise to 90 or 100 percent.³¹ During the 1930's, liming was done on a negligible scale. Indeed, as late as 1954, it is reported that no more than 120,000 acres in the non-chernozem zone were limed, although applications of lime were required on many million more.³² Unquestionably, liming could raise yields from 2 to 5 centners per hectare in spring wheat and from 3 to 7 centners in winter wheat, as tests on experimental farms in the non-chernozem zone have indicated.³³ However, adequate supplies of lime have not been available to the collective farms as a whole.

Similarly, extensive applications of manure are also needed. But in this connection it should be remembered that the drive for a northern wheat base got under way at a time when livestock were being depleted in great numbers in protest against collectivization. Thus, throughout the 30's, manure was in short supply throughout much of the zone. Peat, though abundant, has not been used widely nor extensively; nor have commercial fertilizers been available in sufficient quantities.³⁴ At the same time, other difficulties

exist which have hampered work in the fields. In the party magazine *Kommunist*, the Minister of Agriculture of the RSFSR revealed that "the organization work behind the application of manure and peat on the fields of the kolkhozes of Ryazan and Tula Oblasts, Mari and Mordvin ASSR's, in 1957, was especially unsatisfactory. There, on one hectare of ploughed land in 1957, only 1.1-2 tons of organic fertilizer were applied. Somewhat better was the situation on the kolkhozes of Moscow, Briansk and Vladimir Oblasts, where 3-4 tons were applied to one hectare of ploughed land."³⁵

On the whole, throughout the 1930's, wheat yields in the non-chernozem were low (Table 7).³⁶ In general, they may still be low. Inadequate or incorrect crop rotation practices seem to be chronic. Underlying this situation may well be peasant stubbornness to change, implicit in the "scornful attitudes of the kolkhozy toward the question of agrotechnics and their failure to accept scientific advances in cultivation."³⁷

For their work in developing and adapting new strains and varieties of wheat and other grains, both Tsarist and Soviet agronomists have gained international repute. Yet, despite the success achieved in raising yields and improving quality in experimental fields, the distribution of new varieties to farms throughout the non-chernozem zone, as well as throughout the union as a whole, has tended to lag. During the 1930's, the planting of improved varieties of wheat in the non-chernozem zone probably reached 30-40 percent or more of all wheat sown, although the proportion fell behind the exceptionally high norms established by the Second Five Year Plan.³⁸ Actually, the area sown to improved varieties has tended to fluctuate markedly from year to year, often due to failure of the

³¹ *Ibid.*, p. 103.

³² N. Avdonin, "Vashnye voprosy povysheniia kul'tury zemledeliia v nechernozemnoi polose," *Kommunist*, 1954, No. 9, p. 46.

³³ N. Avdonin, *O Pod'eme Zemledeliia v Raionakh Nechernozemnoi Polosy* (Moscow, 1953), p. 9. Avdonin points out that K. K. Gedroiz, the Soviet soil and agricultural specialist, states that up to 8 and more tons of lime per hectare are required on the soils of the non-chernozem.

³⁴ *Ibid.*, pp. 54-5. In discussing a system of agriculture for the non-chernozem zone, Fredin states that about two tons of manure and peat, and about 22 kgms. of mineral fertilizer per hectare are needed on ploughed land in the non-chernozem zone. See: A. Fredin, "Tvorcheski razrabatat' sistemy zemledeliia," *Ekonomika Sel'skoe Khoziaistvo*, 1957, No. 2, pp. 8-26.

³⁵ I. Benediktov, "Maksimal'no ispol'zovat' rezervy sel'skokhoziaistva," *Kommunist*, 1957, No. 18, p. 48.

³⁶ V. V. Gritsenko, *Agrotekhnika Iarovoii Pshenitsy v Nechernozemnoi Polose* (Moscow, 1955), p. 5.

³⁷ N. V. Kotelnikov, "Osvoenie sevo-oborotov v kolkhozakh nechernozemnoi polosy," *Zemledeliie*, 1953, No. 6, pp. 15-19.

³⁸ *Semenovodstvo i Sortosmena Zernovykh Kul'tur: 1933-1937 gg.* (Leningrad, 1934), p. 27.

kolkhozy to set aside sufficient improved seed for planting the following year.³⁹

CONCLUSION

Wheat can grow in the non-chernozem zone, and it would not have been unreasonable to assume, say in 1927, given the "normal course of events," that the acreage in wheat might have increased in the years to come in response to general improvements in agricultural techniques. Climatic conditions from year to year do present risks; but such difficulties may be offset somewhat by flexible farm management, as well as by the development and cultivation of hardy varieties of winter wheat and early-maturing varieties of spring wheat. Non-chernozem soils do not constitute the best medium for wheat, but drainage, systematic applications of lime and manure, as well as careful cropping, can make some areas productive. Indeed, under such conditions wheat might overtake winter rye in yield and productivity.

The drive for a northern wheat base, however, got under way during a period of revolutionary change and disorder. An ambitious program, it was instituted under the most inauspicious circumstances. Collectivization was imposed and, in the non-chernozem zone, on a peasantry noted for its adherence to traditional and backward ways and methods. The result, if not open opposition, was sullen noncooperation—and the slaughter of livestock by the thousands! Dramatically and suddenly, the non-chernozem zone, where fertilization is imperative, lost a supply of manure at a time when other fertilizers were not readily available.

Under these conditions, the program could not have been assured success. Nevertheless, with considerably expanded acreage, wheat production in the non-chernozem zone by the end of the 1930's must have increased markedly, though falling far short of the regime's expectations.

³⁹ An illustration of this problem is found in the following reference: A. A. Ukolov, "Mezhsortovoe skreshchivanie ozimoi pshenitsy," *Agrobiologiya*, 1954, No. 4, p. 26. Ukolov reports that winter wheat variety *Moskovskaia* 2453, widely sown in Moscow Oblast in the past, has been declining in acreage in recent years, in spite of the fact that its quality is superior to other winter wheat varieties. No one, he points out, has worked at maintaining a supply of seed.

The rationale for establishing a commercial wheat base in the non-chernozem zone, while not necessarily creating regional self-sufficiency, was undoubtedly valid in the eyes of Soviet planners in the early 1930's. As the regime anticipated, the development of a mighty industrial fortress would necessitate a great movement of surplus laborers from the countryside to the cities; the expansion of the urban population in the non-chernozem zone would require that more grain and wheat be made available. Wheat grown in the non-chernozem for market would tend to lessen the length of haul from other regions to the south and east. Moreover, as experience had shown in the past, parts of the steppe region, especially in the Ukraine, could not always be counted on to produce a surplus for shipment to the northern cities. Such a surplus might disappear for some time, too, as a result of black-earth peasant opposition to collectivization. Hence, a supplementary supply of wheat from non-chernozem fields would lessen the dependence on other regions of the country.

However, as Professors Vol'pe and Klupt point out in their *Lectures on the Economic Geography of the USSR* (1957), the average length of haul of grain stuffs in the USSR has tended over the decades to increase, rather than to decrease. From 544 km. in 1913, the length of haul by rail increased to 736 km. in 1940, and to 997 km. in 1954.⁴⁰ It may now be significantly higher, due to the eastward movement of the Soviet wheat belt consequent on the ploughing of more than 70 million acres of virgin and idle steppe lands east of the Volga.⁴¹ In view of the low yields and poor quality of non-chernozem wheat, and as a result of the sharp growth in urban population, the dependence of the non-chernozem zone on imports of grain from the steppe regions, relatively speaking, probably has not lessened to any marked degree.

Vol'pe and Klupt point out that the interests of Soviet national economy demand a significant increase in grain production in the non-chernozem zone, a huge possibility which up to now has not been fully utilized, because

⁴⁰ V. M. Vol'pe and V. S. Klupt, *Lektsii po Ekonomicheskoi Geografii SSSR*, Part I (Leningrad, 1957), p. 202.

⁴¹ Jackson, *loc. cit.*

yields have been low! An increase is possible, they state, through a sharp improvement in agricultural techniques.⁴² In view of what must be a very large and ever-growing demand for meat and dairy products in the industrial cities, we might expect that the Soviet regime will give not less but greater attention to the problems surrounding the grain economy of the non-chernozem zone. However, it is difficult to conceive of a further attempt to expand wheat culture there; indeed, one might expect that, in view of the sharp increase in commodity wheat production in Siberia and northern Kazakhstan, non-chernozem wheat will cause less concern and investment than before 1954. Certainly, by all Soviet accounts, the wheats of the Ukrainian and Siberian steppes are of considerably better quality and are less costly to produce than the wheats of the non-chernozem zone.⁴³

At the same time that the need for a greater output of meat and dairy products has increased, so too has the demand for vegetables and potatoes. The supply of vegetables and potatoes to the state stores of the cities leaves much to be desired,⁴⁴ and without access to the collective farm market, the workers would be severely rationed. Indeed, so great is the

problem of supply that in the latter part of 1958, the Central Committee of the Communist Party ordered 35 sovkhozy in Moscow Oblast to shift to potato and vegetable growing.⁴⁵ In addition, Tula, Briansk, Riazan and Kaluga Oblasts were similarly obliged to intensify land utilization on some of their sovkhozes in order to supply the needs of Moscow.

The key to future land utilization and agricultural production in the non-chernozem zone may already be apparent. The virgin and idle land program in the eastern regions, the corn-livestock program especially in the south, and the ever-increasing demand for meat and dairy products, potatoes and vegetables in the non-chernozem zone, to provide a more varied and substantial diet for the urban population, may weaken substantially the case for a commercial wheat base. Indeed, the XXth Party Congress in 1956,⁴⁶ stressing the need for "specialization" and "the rational distribution" of agricultural activities throughout the USSR, undoubtedly had these considerations in mind. Improved agricultural techniques may bring greater productivity to non-chernozem wheat culture, but the activity may no longer be "rational."

⁴² Vol'pe, *loc. cit.*

⁴³ *Sel'skoe Khoziaistvo SSSR* (Moscow, 1958), p. 131; R. Kartashov, "Voprosy razvitiia zernovogo khoziaistva," *Sotsialisticheskoe Sel'skoe Khoziaistvo*, 1956, No. 2, p. 34.

⁴⁴ *Pravda*, August 20, 1958; *Pravda* notes that the vegetable stores in Tula and other workers' settlements, for example, are uninspiring at any time of the year. The late summer offers no more than green onions, cabbages, and cucumbers, and those not of the best. In 1958, there were no cabbages for sale (from

anywhere) as early as March, and no potatoes as early as May. Ordinarily, there are no onions, garlic, parsley, lettuce, peas, or beans for sale. For a thorough discussion of the problems of suburban truck farming see: N. V. Vasil'ev, *Razvitie Prigorodnogo Sel'skogo Khoziaistva* (Moscow, 1954), 142 pp.

⁴⁵ *Sovetskaia Kirgiziia*, November 4, 1958.

⁴⁶ L. M. Saltzman (ed.), *Voprosy Rashmeshcheniia i Spetsializatsii Sel'skogo Khoziaistva* (Moscow, 1957), pp. 3-4.

THE FILCHNER ICE SHELF¹

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THE world's two largest ice shelves are located on opposite sides of the Antarctic continent. The Ross Ice Shelf south of New Zealand served as the focal point for most of the early exploration in the Antarctic. Through the efforts of such immortals as Scott, Shackleton, Amundsen, and Byrd, the general outline of the Ross Ice Shelf was fairly well delineated in the first decades of the twentieth century. By contrast, the Filchner Ice Shelf is only now being fully explored. This ice shelf lies to the southeast of the southern tip of South America at the head of the Weddell Sea. The clockwise current of the Weddell Sea tends to jam the pack ice against the eastern coast of Palmer Peninsula making access through the western and central portions of the sea exceedingly difficult. As a result of this current action and the remote location, this area has remained until recently almost entirely unknown.

The purpose of this paper is to present a map of the Filchner Ice Shelf and to discuss briefly the major geographical features (Fig. 1). Detailed studies in glaciology, seismology, and geology will follow at a later date.

HISTORICAL BACKGROUND

Captain James Weddell discovered and first sailed into the waters which bear his name in 1823. He penetrated to 74°15'S and 34°17'W in remarkably ice-free waters which gave no indication of the disastrous conditions which were to befall subsequent expeditions. Not until 1912, 89 years after Weddell's voyage and 71 years after Ross discovered the Ross Ice Shelf, did Dr. Wilhelm Filchner reach

Vahsel Bay at 78°S, 35°W and view for the first time the seaward edge of the world's second largest ice shelf.³ After construction of a base at Vahsel Bay, the breaking off of an extension of the ice shelf forced the expedition to abandon their winter program and retreat. The ship was beset and remained in this state for 9 months, drifting some 600 miles in this time. Three years later, in 1915, Sir Ernest Shackleton attempted to take his ship to the southernmost edge of the Weddell Sea with plans for a traverse of 1800 miles across the pole to McMurdo Sound.⁴ Nearing Vahsel Bay his ship, the *Endurance*, was beset and after 10 months was crushed and sunk. A miraculous display of courage and stamina saved all the 28 expedition members. In 1947 Commander Finn Ronne made two important flights from a temporary base on Bowman Peninsula. One of the flights mapped the seaward edge of the Filchner Ice Shelf for the first time, and the second followed the western contact of the shelf with Palmer Peninsula for some distance inland. The land at the head of the Filchner Ice Shelf remained unseen.

For 40 years no ships ventured into the area. In 1955 British and Argentine icebreakers broke into the Weddell Sea to establish bases in conjunction with the International Geophysical Year. The Argentine icebreaker, *San Martin*, was the first ship to reach Gould Bay, the southernmost extremity of the Weddell Sea, 110 miles west of Vahsel Bay.

ESTABLISHMENT OF ELLSWORTH STATION

The USS *Wyandot* sailed from Davisville, Rhode Island, on November 9, 1956, with hopes of establishing a United States I. G. Y.

¹ This study was made possible by support from the U. S. Navy. A U. S. Air Force group under Major Lassiter flew two gasoline resupply flights to the party while in the field and also loaned the party a transmitter.

² The authors were members of the 1957-58 Ellsworth Traverse, part of the United States Antarctic Program for the International Geophysical Year. Mr. Neuburg was Chief Glaciologist; Dr. Thiel, Chief Seismologist; Mr. Walker, Assistant Glaciologist; Mr. Behrendt, Assistant Seismologist; Mr. Aughenbaugh, Geologist.

³ In early May 1957, while "wintering over" at Ellsworth Station, the authors were informed by telegram of the death of Dr. Wilhelm Filchner in Zurich, Switzerland, at 79 years of age.

⁴ It was not until the summer of 1957-58 that the Commonwealth Trans-Antarctic Expedition under Dr. Vivian Fuchs succeeded in completing the journey first attempted 43 years earlier.

the damaged condition of the ships, bad ice conditions, and the failure of a helicopter reconnaissance to reveal a favorable landing site on Bowman Peninsula, the decision was made to turn back. The ships retraced the course along the ice front and a suitable base site was reached on a point of ice to the east of Gould Bay at 77°43'S and 41°08'W. The Task Group had traveled 2000 miles and spent 43 days in the pack ice, 14 days beset. Despite the failure to reach the primary objective, the American ships were the first to sail the waters at the head of the Weddell Sea to the west of 50°W longitude.

Between January 27 and February 10, 1957, 6000 tons of equipment were unloaded, and the base was erected. The ships departed, and the nine scientists and 30 naval support personnel completed station construction and commenced fall and winter projects.

TRAVERSE PREPARATIONS

One of the main phases of the scientific program at Ellsworth Station was to make a detailed investigation of the extent and physical properties of the Filchner Ice Shelf. The endeavor was to be carried out during the summer of 1957-58 on an interior field trip, or traverse, of about 1200 miles. Two specially designed Sno-Cat vehicles drawing cargo sleds were to be used for transporting five persons and necessary equipment.

In order to reconnoiter a possible route for this proposed journey, two major flights were made in single engine de Havilland Otter aircraft. The first of these on March 16, 1957, proceeded 220 miles southeast to survey the Shackleton Mountains and the adjacent heavily crevassed glacier. The Shackletons, the Whichaway Nunataks, and the Theron Mountains had already been seen and charted by the Commonwealth Trans-Antarctic Expedition on numerous flights to their South Ice Station. Approximately 50 miles to the south of Ellsworth the flight crossed Grand Chasm which appeared as a serious obstacle to a direct route inland (Fig. 4).

The second traverse flight took place on October 24, 1957, and headed south for a distance of 300 miles on a true azimuth of 190° from Ellsworth. On this flight the eastern portions of Hubley Island were first defined and the Dufek Massif of the Pensacola Mountains

was circled before the plane turned back. It was later found that these mountains had been observed and photographed on the transpolar flight of Hawkes in early 1956.

Because the Dufek Massif had never been visited on the ground, it was decided for geological interest to make it one turning point of the Ellsworth traverse. From there the group hoped to reach Mount Hassage, near the Orville Escarpment.

Having completed the major projects of the winter, the traverse group, composed of two glaciologists, two seismologists, and one geologist, began preparations for the long trip. Two sleds of 2½ ton capacity were dug out and assembled, and the Sno-Cats underwent major repairs.⁵ During 81 days in the field these vehicles performed well. Their low ground pressure (pounds per square inch) afforded the crossing of countless snow bridges without breakthrough.

The cargo sleds were loaded with gasoline, scientific equipment, and enough food to suffice for a three-month journey. Periodic plane flights from the base were to supply additional fuel and material as requested by radio.

The glaciology program involved two broad types of study. The surface properties of the snow were established from pit studies and coring. The properties of the ice at depth, the thickness of the ice column, and the nature of the underlying bedrock were determined using the techniques of exploration geophysics—seismics, gravity, and magnetics. In addition to research in glaciology the traverse did reconnaissance geological mapping, collected lichens and other plant life, recorded weather observations, measured magnetic declinations (Fig. 2) and vertical intensities, made gravity observations for geodetic purposes, and undertook surveying for map making. Major seismic-glaciological stations were established at 30 to 40 mile intervals and intermediate gravity, magnetic, and surface penetrometer stations every five miles (Fig. 3).

Positions on the trail were determined by sun shots using a Kern one-second theodolite. Elevation control was established by use of

⁵ The authors are indebted to the Commonwealth Trans-Antarctic Expedition for supplying a Sno-Cat clutch plate and spring. The spring served as a model from which we retempered our own badly burned clutch springs, using the galley range and a bucket of kerosene.

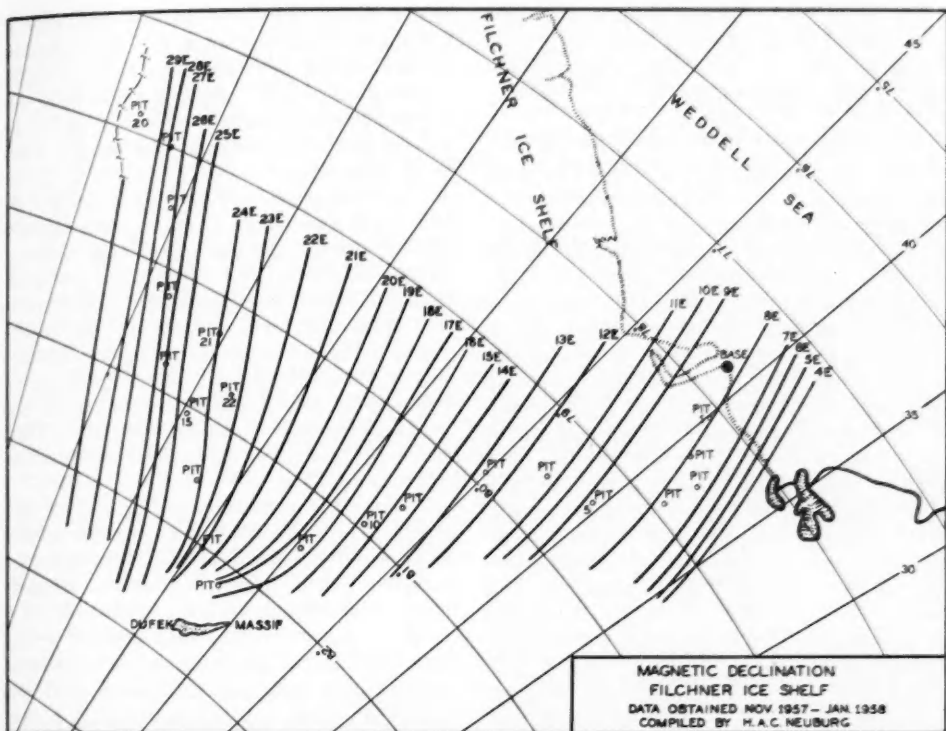


FIG. 2. Magnetic declination map, Filchner Ice Shelf.



FIG. 3. A typical halt for gravity, magnetic and snow penetrometer observations. (Official U. S. Navy Photo.)

two Wallace and Tiernan altimeters on the trail and one at the base. A Sperry gyrocompass and a magnetic surveying compass were used for trail directional control.

GRAND CHASM AND OTHER ICE SHELF FEATURES

Gould Bay is similar to the Bay of Whales. Like the Ross Ice Shelf embayment, it is a semi-permanent though varying feature which owes its existence to the ice shelf flowing around an ice-covered island.

Fifty miles south of Ellsworth, trending in an east-west direction and parallel to the shelf edge, is a gigantic rupture in the ice shelf, Grand Chasm. This grandfather of all crevasses is sixty miles long and from a quarter to three miles wide. The jumbled ice mass in the bottom lies 175 feet below the shelf level, but the rupture must extend through the entire shelf, which, at the ice front, is 800 feet thick. Grand Chasm is an impressive and memorable sight from the air, but on the "ground" it is an obstruction similar to the canyons in the western United States. A slight offset of the rupture occurs so that the chasm is divided into two nearly equal parts (Fig. 4).

The ice shelf is crevassed at both ends of the chasm. This feature thus posed a problem to the traverse in that it literally fenced Ellsworth in from the rest of the ice shelf. Air reconnaissance showed a detour about the eastern extremity to be the only feasible route to the interior.

The field party left Ellsworth October 28, 1957, and traveled in a southeastern direction until it intercepted the north edge of Grand Chasm 80 miles from the station. The party then followed the northern edge eastward to its termination, and, with a plane guiding the vehicles from the air, successfully bypassed this obstacle and the associated crevasses. To the south of Grand Chasm several parallel and physically similar ruptures were noted. These smaller rifts are less than a mile wide and five to ten miles long.

Among the characteristics of an ice shelf are the rolls or undulations which occur on its surface. The size and extent of these features differ with the locality. Some are insignificant while others may have a wave length of close to a mile and an amplitude of several hundred feet. The most notable undulations were encountered to the north of Dufek

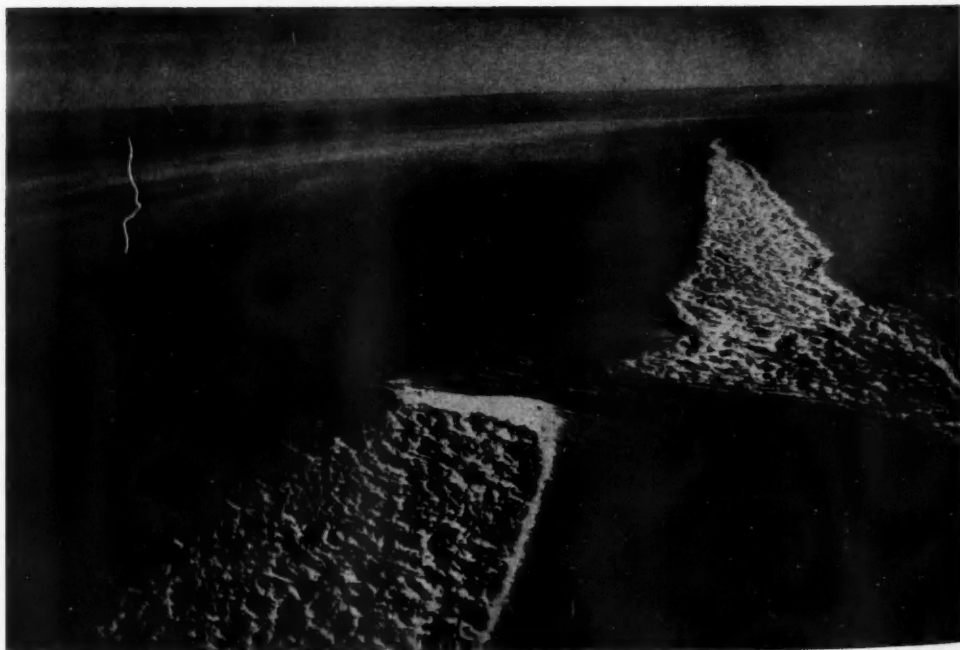


FIG. 4. Grand Chasm viewed from the east, showing the offset near its center. (Photo by H. A. C. Neuburg.)

Massif. These rolls were parallel to the range and were the deepest the traverse party crossed. Other undulations were encountered: (1) near the ice front and parallel to it, (2) just north of Grand Chasm with orientations in various directions, (3) east of McCarthy Escarpment and perpendicular to it, and (4) in Brown Strait parallel to Korff Island.

Large sections of the Filchner Ice Shelf are crevassed. The map illustrates the location and approximate size of the fields encountered by the traverse, although some are believed to be much more extensive than illustrated. Several types of crevasses were found. The most dangerous for surface travel were the small arcuate, bridged ones that looked quite harmless from the air. By contrast, it was possible to drive with comparative safety between the more spectacular, long, parallel types. The northern front of Dufek Massif was surprisingly crevasse free. Hubley Island, with the exception of Jaburg Ramp, appeared to be surrounded by chaotic ice fields.

Two places on Korff Island had large cone-shaped ice hummocks. These features were seen from several miles, but not visited. Similar but smaller cone features called "haycocks" were observed along the ice front.⁶

Prominent strand cracks were noted on the northwest edge of Malville Peninsula. These cracks in the transition zone from grounded to floating ice ran parallel to the assumed shoreline, were two to six inches wide, and seemed to be constantly working in that they cut even the largest sastrugi.⁷

HUBLEY ISLAND

At the west cape of Gould Bay lies an ice-covered upland seen for the first time by the American I. G. Y. expedition. In the vicinity of 48°W longitude the upland slopes steeply down to sea. Here a helicopter reconnaissance flight in January 1957 found an Emperor Penguin rookery, the ninth to be discovered in the

Antarctic. A count in November 1957 gave a population of approximately 8000 birds.⁸

Bordered on the east by steep crevassed escarpments and several embayments, Hubley Island presented a formidable obstacle to the traverse. Twice, the vehicles sank into crevasses, but after probing and repairs, the highland was attained (Fig. 5).



FIG. 5. Probing a route towards McCarthy Escarpment on the eastern side of Hubley Island. (Photo by P. T. Walker.)

The highest elevation encountered enroute across the southeastern corner of the island was 2500 feet. The underlying rock surface at this point was determined seismically to be near sea level. Since the altimetry results of the air reconnaissance flight of October had indicated that the highest point of the island lay to the northwest of the traverse route, it is possible that the rock surface in that region rises above sea level.

⁶ For reference to haycocks see Gould, *Cold* (New York: Brewer, Warren and Putnam, 1931).

⁷ For further discussion of strand cracks see Swinbank, "The Morphology of the Ice Shelves of Western Dronning Maud Land," *Glaciology I, Norwegian-British-Swedish Antarctic Expedition, Scientific Results*, Volume III (Oslo: Norsk Polarinstitutt, 1957), pp. 19-22.

⁸ J. M. Malville, personal communication.

Midway between Dufek Massif and Korff Island another ice-covered upland rises above shelf level. On the map this upland is designated Malville Peninsula, although it is not certain that the term "peninsula" is correct. Conceivably this upland could be an isthmus connecting Hubley Island with the interior plateau to the southwest, or an island surrounded on all sides by ice at shelf level. The highest point encountered by the traverse on crossing this upland was 750 feet above the adjacent ice shelf.

CRARY TROUGH

Many years ago Griffith Taylor postulated a downwarp or trough between the Ross and Weddell seas.⁹ This theory occurred to Taylor as a result of his studies of Antarctic geography and of the geology of the adjacent South American and Australian continents. In South America the pre-Cambrian area of the Brazilian Highlands is separated from the geologically young Andean Mountain chain by the low-lying valley of the Rio del Plata. The pre-Cambrian shield of western Australia is likewise separated from the eastern Australian Highlands by a lowland area. By analogy, Taylor reasoned that the pre-Cambrian shield of east Antarctica should be separated from the Tertiary Mountains of Palmer Peninsula by a low-lying trough or syncline.

The seismic work of the Ellsworth traverse detected a deep trough to the east and south of Hubley Island. The first indication of this trough was recorded on the fathometer record of the *Wyandot* as the ship steamed along the ice front. Opposite Belgrano an ocean depth of 3750 feet was measured. The Ellsworth traverse four times crossed the axis of the trough. Leading southward from Belgrano for 160 miles, the trough swings southwest, passing between Hubley Island and Dufek Massif. The bottom of the trough averages 3500 feet below sea level. It continues southwest beyond the limits of the traverse. Further work is necessary before it can be said whether this depression extends all the way to the Ross Sea. The results of the second season of the American I. G. Y. traverse activity should contribute greatly to the solution of this problem.

⁹ Griffith Taylor, *Antarctic Research and Adventure* (New York: D. Appleton and Company, 1930), pp. 83-89.



FIG. 6. Southwest end of Dufek Massif viewed from the north. (Photo by P. T. Walker.)



FIG. 7. Horizontal banding and Alpine topography of Dufek Massif. (Photo by N. B. Augenbaugh.)

Ocean depths to the northwest of Malville Peninsula are shallow. Since a division of Antarctica into East and West on the basis of topography would most logically follow the axis of Crary trough, Ellsworth and Hubley Island might be said to lie in West Antarctica.

DUFEK MASSIF

On December 9, 1957, the field party reached Dufek Massif, the southernmost limit of the traverse (Fig. 6). Six days were spent investigating the range's many unusual features.

Dufek Massif borders the southeastern edge of the Filchner Ice Shelf at latitude $82^{\circ}40'S$ and between longitudes 50° and 54° West. The exposed part of the range is approximately 30 miles long, two to ten miles wide, and 4000 to 8000 feet above sea level. It protrudes over 5000 feet above the ice.

This mountain mass is one of the northwestern ranges of the Pensacola Mountains, a series of half buried ranges which extend in a northeast-southwest direction. The Horlick Mountains border them on the west and the Shackleton Mountains lie on their eastern edge. Thus there seems to be one continuous S-shaped mountain chain from Victoria Land and the western edge of the Ross Sea to Coats

Land on the eastern boundary of the Weddell Sea.

From a distance the peaks show a distinct horizontal banding or layering which gives the observer an impression of a thick sequence of undisturbed sediments (Fig. 7). However, a closer examination discloses that the range is igneous with gabbro the prominent rock. The banding is due to a slight compositional change which gives each layer a different color hue. The reason for such controlled differential composition is puzzling. Two possible explanations are: (1) a series of sediments that have been completely altered to igneous-type rocks, or (2) a large igneous intrusion in which the magma developed layering through segregation during cooling.

There are numerous mineralized zones in which metallic ores are found. Iron, copper, and chromium minerals are the most abundant. The isolation of the range prohibits any economic importance at the present time.

Dufek Massif is large enough to support many valley and cirque glaciers. These glaciers, with the help of frost action, have molded an alpine type topography. The northeastern section of the range, which is much lower than the central and western portions, has several small outlet glaciers flowing



FIG. 8. An ice-free valley on the northeastern slope of Dufek Massif. Note the terminal moraines paralleling the ice edge. (Photo by P. T. Walker.)

through the lower saddles like frozen rivers. A sizeable snow field caps the central portion of the massif. Moraines are present with heights which indicate that the ice sheet was at least 300 feet thicker in this region at one time. Blue ice occurs in many areas near the foot of the range. Whether this is refrozen meltwater or old glacier ice is a point of conjecture. Pockets of dirt and rocks are found on the ice where they have melted in, and the ice has refrozen over them.

Several unique ice-free valleys were found on the northeastern flank of the range (Fig. 8). These areas are covered with patterned ground which gives a striking mosaic appearance. Near the center of one valley is a small meltwater lake, 100 yards in diameter and a few feet deep (Fig. 9). On its bottom grows a primitive, leafy type water plant, of which specimens were collected for study by botan-

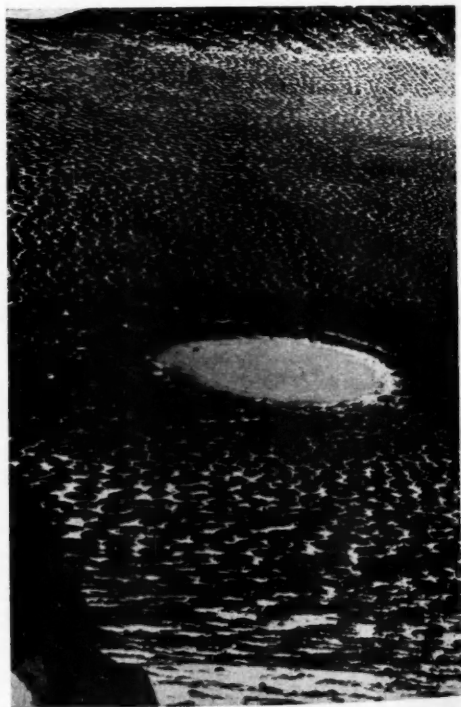


FIG. 9. Meltwater lake on the north slope of Dufek Massif. Note the patterned ground and previous high water mark of the lake. (Photo by P. T. Walker.)

ists.¹⁰ The only other forms of plant life seen were a very few yellow lichens and black lichens, growing sparsely in protected places. Some bird tracks, larger than those of the snow petrel, were found on a ridge.

KORFF ISLAND

Near the northwestern limit of the traverse the trail crossed a crevasse field two miles wide and climbed the terraced southeast slopes of Korff Island. This highland, trending in a northeast-southwest direction, is about twenty miles wide where crossed. Although its crest rises to an elevation of 1300 feet, seismic studies indicate that the underlying bedrock is below sea level. The term "island" is applied since this feature rises prominently above the surrounding sea of shelf ice. This "island" may actually be a peninsula.

Near the island a set of tracks, which might

¹⁰ This alga has been identified as *Phormidium incrustatum* (Naeg.) Domong, with possibly some *retzii*. Identification was made by Drs. George Llano and George Prescott, personal communication, August 1958.

have been made by a penguin, was found on the ice shelf, 200 miles from the nearest open water. Bonafide penguin tracks were found by the Byrd Land traverse about the same distance inland.¹¹

Lying thirty miles to the northwest of Korff Island is a paralleling highland which may be the extension of the Orville Escarpment. Protruding above it, Zumberge Nunatak was seen from the northwest slopes of Korff Island. This isolated peak is snow covered for most of its height; only at the very top does the jagged, dike-like rock protrude. A visit to the nunatak was precluded by dense crevassing in Brown Strait.

CONCLUSION

The 1957-58 Ellsworth traverse found the Filchner Ice Shelf to be of much greater extent than previously supposed. Preliminary calculations indicate its area to be approximately 160,000 square miles. By comparison, the Ross Ice Shelf has an area of 210,000 square miles.

¹¹ N. A. Ostenso, personal communication.

FEDOROV'S COMPLEX METHOD IN CLIMATOLOGY

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A recent article in the *Annals* has reminded American climatologists of the existence of a contemporary Soviet school of climatology that stands apart from most of the climatological thinking in other countries, that is, E. E. Fedorov's "Complex Method in Climatology."² But the fact that most articles on the nature of climatology ignore this Soviet school of thought makes it evident that the so-called "complex climatology" is little known and little understood in the United States. Surely it should be worthwhile for American climatologists to be versed in the development of the complex method, not only because it represents a separate school of thought that must be taken into account in any total picture of the field of climatology today, but also because it provides the prime example for the case study of an actual attempt to grasp somehow the immeasurable "*Gestalt*" of the instantaneous weather of a place and to work this nebulous and undefined unit into a quantitative system of classification. This desire, to more truly depict weather conditions than is done by traditional use of statistics of individual elements, is not a new desire among climatologists, but no one before has gone so far in the attempt to devise an elaborate system for handling basically incommensurable, unprecise quanta objectively.

Fedorov was an idea man, a philosopher, who was always groping into the unknown. His thoughts constantly carried him beyond the realm of the practicable, so that his concepts were frequently impossible of complete communication. Therefore, his writing is somewhat fragmentary, often only shallow expressions, in terms of the real aspects of climate that do occur, rather than expressions encompassing his entire thought and leading to the ideal that he sought. His students have acknowledged his originality of thought and

have appreciated the fact that he has provided them with a mental exercise, but most of them have despaired of the possibilities of ever reaching any ultimate conclusions and have worked along more traditional lines. A few have taken up the torch; acting as organizers and publicity men, they have, on the one hand, striven to iron out all mechanical difficulties in the scheme, and on the other hand, to bring the new methodology to the attention of the general scientific world. L. A. Chubukov particularly has acted as a disciple in this respect; again and again, in speeches and in articles, he has reiterated the growth of the school of thought and defined its position at the present time, pointing out its good features and the improvements that have been made on the original statement. Fedorov himself has not pretended to be conclusive; his work lies ever open to new ideas, new procedures. But more about this later; what of the complex method itself?

CIPHER CODE AND GRAPHIC REPRESENTATION

Fedorov devised a system whereby he characterized each day's weather by a group of symbols and entered these symbols in the "weather card catalog" for each station for future use. Many elements were included in the code characterization, so that a very detailed classification into "weather types" resulted. As Fedorov said, in the initial classification it is best to work with great detail so that any conceivable use may be served; generalization of the data can be made in each individual study to suit the needs. He then experimented with various types of graphic presentations of his weather types, and attempted to establish procedures whereby his weather-type classification could be used both in applied fields and in the study of "climate genesis."

The full and exact codification of the complex method is difficult to describe because it has grown piece-meal and has been modified from time to time. Fedorov's ideas began very nebulously in the early 1920's and were still in the formative stage when he described them in print in 1925 and 1927. The basic cipher code was published in an article in 1925, which,

¹ The research for this paper was done largely while the author was a Ford Foundation Fellow at the University of California at Berkeley. The author is indebted to Edward T. Price for reading the manuscript and offering valuable suggestions.

² Arnold Court, "Climatology: Complex, Dynamic, and Synoptic," *Annals*, Association of American Geographers, Vol. 47, No. 2 (June, 1957), pp. 125-36.

TABLE 1.—FEDOROV'S CIPHER CODE FOR CLIMATE CLASSIFICATION, IN FOUR PARTS BY LETTERS OF CODE¹
First Letter: Character of the Wind

Winds of Constant Direction (in m/s)					Winds of Variable Direction				
Direction according to rhumbs	Moderate	Fresh	Strong	Gale	Direction according to quadrants	Moderate	Fresh	Strong	Gale
	1-3	4-7	8-13	14-18 ²		1-3	4-7	8-13	14-18 ²
	2-4	5-10	11-18	19-24 ³		2-4	5-10	11-18	19-24 ³
	3-6	7-15	16-26	27-36 ⁴		3-6	7-15	16-26	27-36 ⁴
N	a	A	a	A	Shifting from one quadrant to another:				
NNE	b	B	b	B					
NE	c	C	c	C	N-ENE to E-SSE	j	J	j	J
ENE	d	D	d	D	E-SSE to S-WSW	k	K	k	K
E	e	E	e	E	S-WSW to W-NNW	l	L	l	L
ESE	f	F	f	F	W-NNW to N-ENE	m	M	m	M
SE	g	G	g	G	N-ENE to W-NNW	n	N	n	N
SSE	h	H	h	H	W-NNW to S-WSW	p	P	p	P
S	s	S	s	S	S-WSW to E-SSE	q	Q	q	Q
SSW	t	T	t	T	E-SSE to N-ENE	r	R	r	R
SW	u	U	u	U	Shifting infrequently	i	I	i	I
WSW	v	V	v	V					
W	w	W	w	W					
WNW	x	X	x	X					
NW	y	Y	y	Y					
NNW	z	Z	z	Z					
Winds Without Direction					Cases of light winds only during the night or only during the day are shown by the symbol ° before or after the letter; cases of changing strength of wind by the symbol ' before or after the letter.				
Calm (less than 1 m/s)			o						
Light winds (1-2 m/s)			O						

¹ From E. E. Fedorov, "Klimat, kak sovokupnost' pogod," *Meteorologicheskii Vestnik*, Vol. 35, No. 7 (July, 1925), pp. 161-69.² Applicable when the weather vane is very low.³ Weather vane projects above surrounding objects.⁴ Weather vane very high.

Second Letter: Character of the Temperature

Mean daily temperature	Diurnal Amplitude														
	0.0-4.9°C			5.0-9.9°C			10.0-14.9°C			15.0-19.9°C			20.0-24.9°C		
	Difference in mean temperature from preceding day														
	5°C VII	5°C ∧	5°C ∨	5°C VII	5°C ∧	5°C ∨	5°C VII	5°C ∧	5°C ∨	5°C VII	5°C ∧	5°C ∨	5°C VII	5°C ∧	5°C ∨
	Change	Increase	Decrease	Change	Increase	Decrease	Change	Increase	Decrease	Change	Increase	Decrease	Change	Increase	Decrease
Below zero:															
42.4-32.5°C	q	r	s	Q	R	S	q	r	s	Q	R	S	q	r	s
32.4-22.5	t	u	v	T	U	V	t	u	v	T	U	V	t	u	v
22.4-17.5	w	x	y	W	X	Y	w	x	y	W	X	Y	w	x	y
17.4-12.5	z	a	b	Z	A	B	z	a	b	Z	A	B	z	a	b
12.4- 7.5	c	d	e	C	D	E	c	d	e	C	D	E	c	d	e
7.4- 2.5	f	g	h	F	G	H	f	g	h	F	G	H	f	g	h
2.4- 0.0	i	ii	ij	I	Ii	Ij	i	ii	ij	I	Ii	Ij	i	ii	ij
Above zero:															
0.0- 2.4	j	ji	jj	J	Ji	Jj	j	ji	jj	J	Ji	Jj	j	ji	jj
2.5- 7.4	k	l	m	K	L	M	k	l	m	K	L	M	k	l	m
7.5-12.4	n	o	p	N	O	P	n	o	p	N	O	P	n	o	p
12.5-17.4	q	r	s	Q	R	S	q	r	s	Q	R	S	q	r	s
17.5-22.4	t	u	v	T	U	V	t	u	v	T	U	V	t	u	v
22.5-27.4	w	x	y	W	X	Y	w	x	y	W	X	Y	w	x	y
27.5-32.4	z	a	b	Z	A	B	z	a	b	Z	A	B	z	a	b
32.5-37.4	c	d	e	C	D	E	c	d	e	C	D	E	c	d	e
37.5-42.4	f	g	h	F	G	H	f	g	h	F	G	H	f	g	h
42.5-47.4	i	ii	ij	I	Ii	Ij	i	ii	ij	I	Ii	Ij	i	ii	ij

TABLE 1.—Continued

Third Letter: Character of Cloudiness, Humidity, and Precipitation

Cloudiness		Without significant precipitation (< 1 mm.) ³					With significant precipitation (≥ 1 mm.) at various times of day				
During ¹ night	During ² day	Humidity in percent					Time of occurrence of precipitation	Humidity in percent			
		100-81	80-61	60-41	40-21	20-0		100-81	80-61	60-41	40-20
<2	<2	o	O	o	O	P	Before noon	b	B	b	
<6	<6	a	A	a	A	B	After noon	c	C	c	C
							Before and after noon	d	D	d	
6-10	<6	e	E	e	E	F	Before noon	f	F	f	
							After noon	g	G	g	G
							Before and after noon	h	H	h	
<6	6-10	i	I	i	I	J	Before noon	k	K	k	
							After noon	l	L	l	L
							Before and after noon	m	M	m	
<6	6-10	j	J	j			Before noon	n	N	n	
(Used when there are significant amounts of cumulus)							After noon	p	P	p	
							Before and after noon	q	Q	q	
6-10	6-10	u	U	u			Before noon	r	R	r	
							After noon	s	S	s	
							Before and after noon	t	T	t	
>8	>8						Before noon	v	V	v	
(lower clouds)		y	Y	y			After noon	w	W	w	
							Before and after noon	x	X	x	
							All day	z	Z	z	
Continuous fog	Y						Before noon	V			
							After noon	W			
							Before and after noon	X			
							All day	Z			

¹ Night cloudiness is average for 9 p.m. and 7 a.m.² Day cloudiness is for 1 p.m.³ Also variously set at 2.5 mm. and 0.6 mm.!

Fourth Letter: Character of Various Phenomena in the Atmosphere and the State of the Ground Surface

Ground surface not frozen	Surface of ground (morning)				Ground surface frozen or with snow cover	Heavy sleet	Rain	Heavy snow storm	Other
	Hoar frost	Wet (soggy)	Dew	Dry					
Without pouring rain and thunderstorm	A	a	A	a	Without snow cover	O	o	O	o
Thunderstorm with heavy showers ≥ 10 mm.					Snow cover without designated depth:				
At night		b			Relatively even depth	P	p	P	p
Before noon	C	e	C	c	Very uneven depth	Q	q	Q	q
After noon	D	d	D	d	Deep snow cover:				
At night and before noon		B			Relatively even depth				
At night and after noon		b			1-5 cm.	R	r	R	r
Before and after noon	E	e	E	e	6-25	S	s	S	s
At night, before, and after noon		B			26-75	T	t	T	t
					>75	U	u	U	u
Thunderstorm with rain, but not heavy showers 1-10 mm.					Discontinuous				
At night		f			1-5	V	v	V	v
Before noon	G	g	G	g	6-25	W	w	W	w
After noon	H	h	H	h	Very uneven depth				
At night and before noon		F			26-75	X	x	X	x
At night and after noon		f			>75	Y	y	Y	y
Before and after noon	I	i	I	i	Ice glaze	Z	z	Z	z
At night, before, and after noon		F							

TABLE 1.—Concluded

Fourth Letter: Character of Various Phenomena in the Atmosphere and the State of the Ground Surface

Ground surface not frozen	Surface of ground (morning)				Ground surface frozen or with snow cover	Heavy sleet	Rain	Heavy snow storm	Other
	Hoar frost	Wet (soggy)	Dew	Dry					
Thunderstorm without rain < 1 mm. and distant thunderstorm									
Before noon	J	j	J	j					
After noon	K	k	K	k					
Before and after noon	L	l	L	l					
Snow in the forests but not on the fields	M	m	M	m	Snow in the forests but not on the fields	N	n	N	n

Fog denoted by: morning, short line between third and fourth letters; evening, after the fourth letter; morning and evening, two lines before the fourth letter. Heavy hail in summer, and ice glaze on roads in winter indicated by the symbol ° behind the fourth letter. Heavy shower without thunder indicated by 1 after fourth letter.

with additions and modifications from subsequent work, is shown in Table 1. Each day's "totality of weather" is typed by means of a four-letter combination. Using all 26 letters of the Latin alphabet and four variations of each letter (capital and lower case letters, light and bold-face or underlined type), 104 characters are available, which present over 100,000,000 possible combinations using four letters at a time.

Each letter stands for so much information that it is quite impossible to commit the code to memory; one must refer to the code table constantly, both in encoding present weather and in decoding past weather. Fedorov might have done well to make use of more symbols in each weather-type designation, perhaps allowing a separate symbol for each weather element. A code involving more symbols, in definite order, each representing a precisely limited amount of information, could be more easily mastered than can a code consisting of so few symbols, each of such complex meaning. Proof of this statement is the synoptic weather map code, which encompasses just as much information as Fedorov's cipher code, and which, after all, is memorizable.

The one big deficiency in the code system is the lack of incorporation of any method to represent amounts of precipitation. Throughout Fedorov's work with the complex method, precipitation is undoubtedly the most inadequately portrayed of the significant elements of climate. To show merely frequencies of occurrences of precipitation above a certain minimum amount seems quite inadequate, particularly in the consideration of plant

growth, which is supposedly the prime basis for the making of value judgments in his system. Fedorov's only defense for this omission is the fact that diurnal amount of precipitation is measured from 7 a.m. to 7 a.m., and this period is not coincident with the 24-hour period, 9 p.m. to 9 p.m., which he has rather arbitrarily defined as being the basic unit of time for his weather type classification! This ridiculous excuse he deems necessary to offer only once in his entire writing, quite inconspicuously in a footnote.³

Fedorov recognized that so precisely defined combinations of weather elements exist only instantaneously and change constantly; that to be entirely precise, one would have to deal with the combinations of instantaneous weather. But these "weather cases" or "weather haps," as he terms them, would be of infinite number; so in order to make the system usable he has synthesized the weather for a 24-hour period, "a natural period of time," he says. A given 24-hour period, of course, more likely than not, will not coincide with the extent of a given type of weather; at times, it may be only a part of a longer period over which a given weather setup has extended; or, more serious, it might incorporate the breaking point between two very different weather situations, such as is the case when frontal passages occur. Fedorov offers no explanation of how to codify a

³ E. E. Fedorov, "Klimat kak sovokupnost' pogod," *Meteorologicheskii Vestnik*, Vol. 35, No. 7 (July, 1925), fn. 1, p. 165: "... amount of precipitation is introduced only infrequently owing to the fact that the 24-hour period for amount of precipitation does not coincide with that decided upon for the classification."

<div style="display: flex; justify-content: space-between; align-items: center;"> 12 <u>VII</u> 1939 </div> <div style="text-align: center; margin-top: 50px;"> <p>Москва</p> </div>	<div style="text-align: center; font-size: 2em; margin-bottom: 20px;"> $Z V_{15}^{23} D^{73} a$ </div> <div style="text-align: center;"> $\Phi_x M_{II}$ B^{CB} </div>
---	--

FIG. 1. Weather card for Moscow, 12 July 1939; views of both sides of card. On one side are shown the date, at the top, and the station name, at the bottom. On the other side are shown the four-letter code designating the weather type, at the top, and, at the bottom, a group of letters from the Russian alphabet designating frontal passages, air masses, and position with respect to air pressure centers. From L. A. Chubukov, *Novoe v uchenii o klimate* (Moscow, 1949), p. 12. The symbols stand for the following information: Z, wind northwest 4-7 meters per second V_{15}^{23} , average 24-hour temperature (9 p.m. to 9 p.m.) 17.5-22.4°C, maximum temperature 23°C, minimum temperature 15°C, diurnal amplitude of temperature 8°C, change in average temperature from preceding day—decreased more than 5°C; D^{73} , lower clouds during night and day less than 6/10 coverage, average 24-hour relative humidity 61-80%, relative humidity at 1 p.m. 73%, precipitation up to and after noon less than 2.5 millimeters; a , surface of ground in morning was dry; Φ_x , under the influence of a passing cold front; M_{II} , after passing of cold front, fresh maritime polar air; B^{CB} , located in northeast periphery of high pressure area.

24-hour period which has two or more distinctly different weather types.

With its various shortcomings, this code has remained essentially intact as the code used in entering the daily weather types in the card catalogs, but it has been modified and abbreviated to some extent in other forms of usage. Often the first letter is replaced by a number that represents wind velocity only, without direction, and the last letter often is omitted (e.g., Table 2). At the present time, there are apparently several variations of the basic code, most of them slight variations, in general

merely refinements of the statistical intervals of the various weather elements, so that a more complicated symbolic system is involved. This has been particularly true in the case of the second and third letters of the cipher code. An addition of real significance has been made in one code variant in which subscripts have been added to the third letter to indicate amounts of precipitation to some degree of accuracy.⁴

⁴ For an example of this code modification see L. A. Chubukov, *Kompleksnaya Klimatologiya* (Moscow, 1949), Appendix, pp. 90-93.

FIG.
light,
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other
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toward
short
Adapt
geofiz

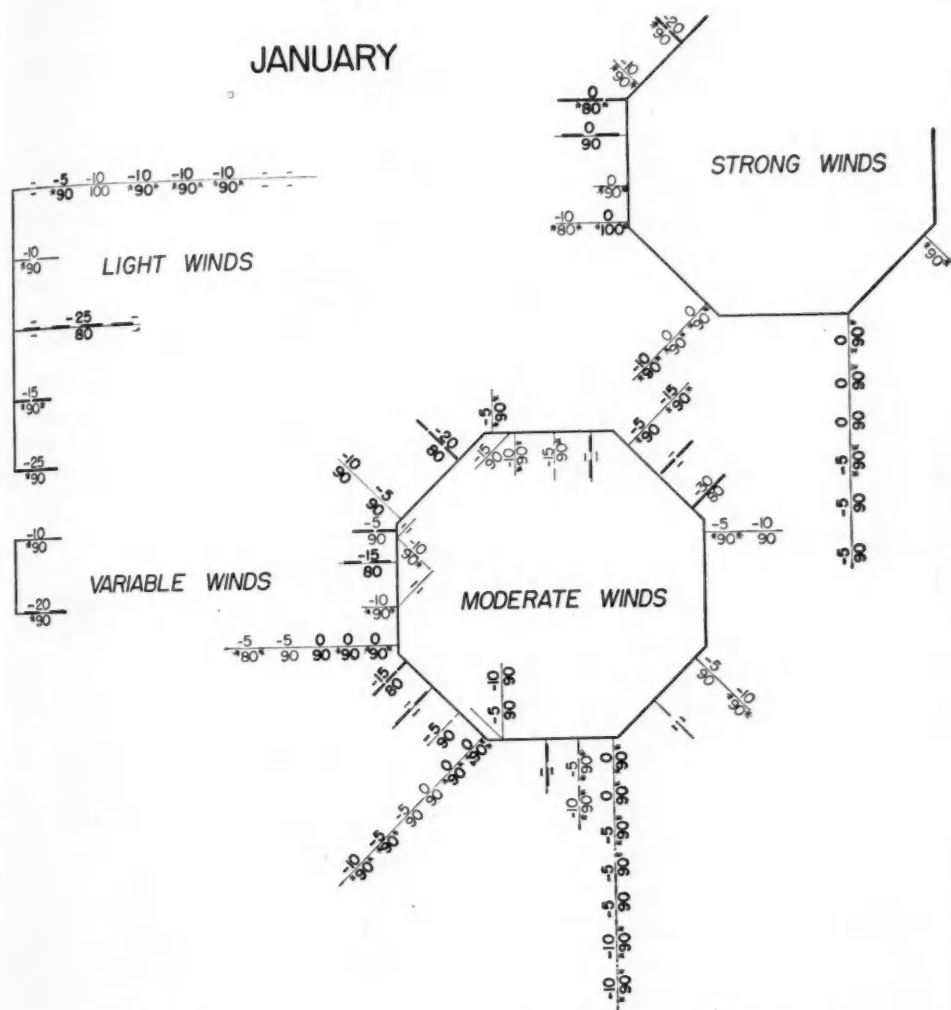


FIG. 2. Normal January conditions of weather for many years at Slutsk (Pavlovsk), near Leningrad. Wind: light, 0-2 meters per second; moderate, 3-6; strong, over 7 meters per second. Directions given to eight rhumbs. Each anemometer was approximately 20 meters above surrounding objects in the forest and 40 meters above the ground. Cloudiness: Thick line, clear; thin line, overcast; thick and thin, average; interrupted line, changing from higher to lower clouds and vice versa. Temperature: Number above line, to nearest 5°C. Relative humidity: Number below line, to nearest ten percent. Precipitation (more than one millimeter): Rain ●; snow °. If the symbol is shown before the number, precipitation occurred before noon; if after the number, after noon. Boldface figures signify that those particular weather conditions occur about once in three years; other figures, once in five years. The segments of straight lines inside the octagons represent days with abruptly shifting winds. They are attached to the side which represents the original direction and are directed toward that which represents the final direction. For cases shown only by wind and cloud conditions, with short lines in place of temperature and humidity figures, temperature and humidity data were not available. Adapted from E. E. Fedorov, "Opyt izucheniya pogody mesyatsa po pogodam otel'nykh dni," *Zhurnal geofiziki i meteorologii*, Vol. 2 (1925), p. 226.

RELATIVE HUMIDITY

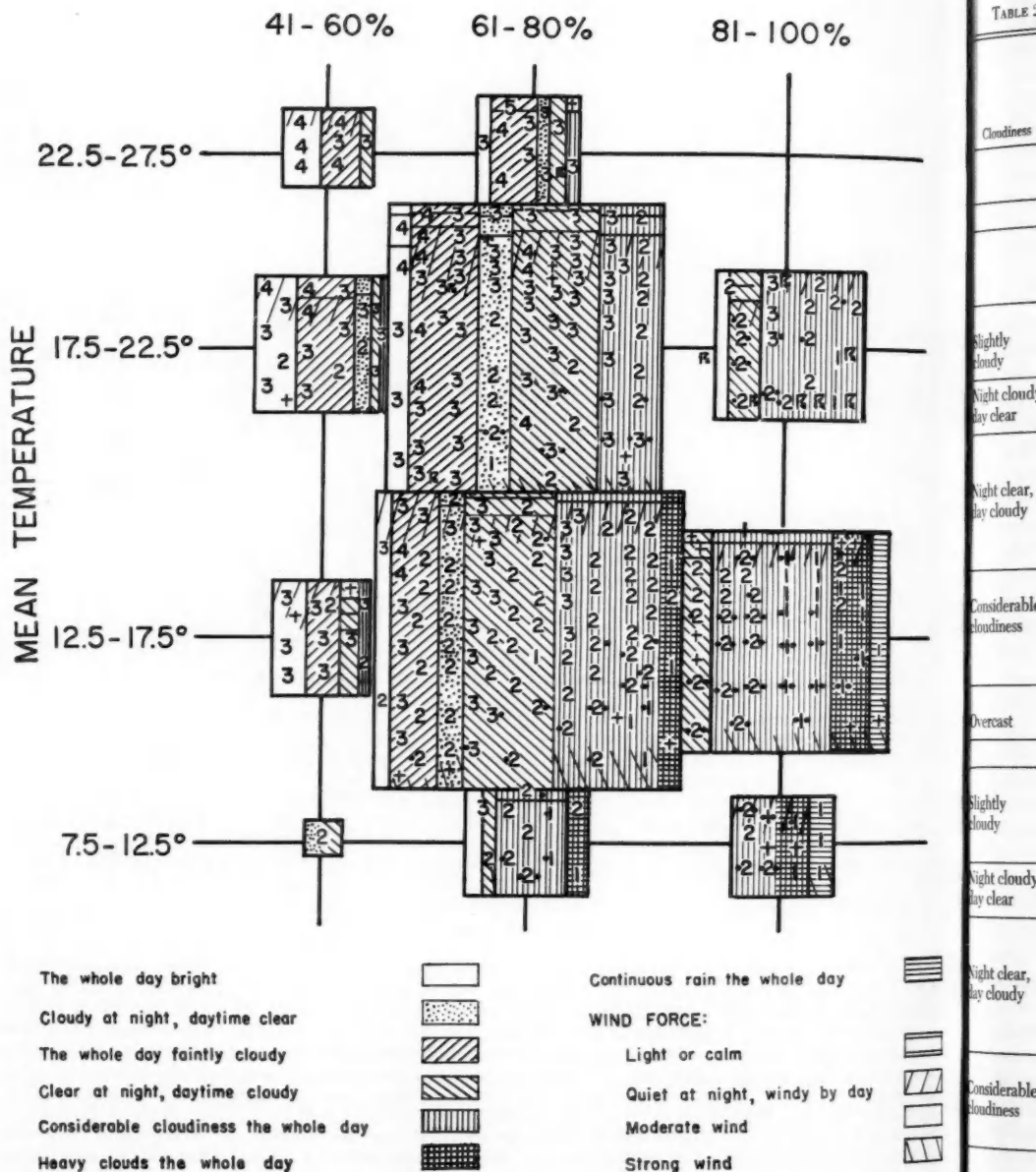


FIG. 3. Normal July weather at Pavlovsk. As shown in E. S. Nichols' translation of E. E. Fedorov, "Das Klima als Wettergesamtheit" in the *Monthly Weather Review*, Vol. 55 (Sept., 1927), p. 402. Amplitude of temperature (daily range) is indicated by figures entered on the shaded areas: below 5°C, by the figure 1; between 5°C and 10°C, by figure 2; between 10°C and 15°C, by figure 3; etc. The number of times that each figure appears on the graph is the number of times that that amplitude of temperature occurred in July in a ten-year period. Precipitation is shown by the following symbols: rain ●, thunderstorm R, frost ⊥. These symbols are placed before or after the figures according as the occurrence was before or after noon.

TABLE 2.—APPLICATION OF FEDOROV'S CIPHER CODE TO TYPES OF WEATHER AND THEIR FREQUENCIES AT PAVLOVSK¹

		Wind												
Cloudiness	Humidity	O		°1		1				2				
		Calm		Night calm	day windy	Moderate wind				Strong wind				
Temperature														
		27½	22%	17%	22%	17%	27%	22%	17%	12%	27%	22%	17%	12%
		22%	17%	12%	17%	12%	22%	17%	12%	7%	22%	17%	12%	7%
Without Rain														
	41-60	OTa 1		°1Ta 2		1Wa 3	1Ta 2							
		Ota 1		°1ta 2	°1qa 3	1wa 2	1ta 6	1qa 3			2wa 1	2ta 1		
							1Ta 1	1Qa 2				2Ta 1		
Slightly cloudy	61-80	OWA 1	OTA 3	OQA 1	°1TA 4	1WA 3	1TA 5							
		Owa 1	Ota 3	OqA 1	°1ta 7	°1qa 5	1wa 6	1ta 21	1qa 11		2wa 1	2ta 1		
			OTA 1		°1QA 1			1TA 5	1QA 7			2TA 1	2QA 2	
Night cloudy, day clear	61-80			°1tE 1			1tE 1							
				°1TE 1	°1QE 1		1TE 2	1QE 3	1NE 1					
	41-60								1Qi 1					
Night clear, day cloudy	61-80	Oti 1		°1TI 1	°1ti 2	°1qi 3	1ti 5	1qi 4			2ti 1			
			OQi 2		°1QI 1		1TI 2	1QI 8	1NI 2		2TI 1	2QI 1		
									1ni 1			2qi 1		
	81-100						1Ti 1	1Qi 2						
Considerable cloudiness	61-80						1TU 1	1QU 5	1NU 1					
	81-100							1qu 1	1nu 1				2qu 1	
								1Qu 1						
								1qu 1	1nu 1					
Overcast	61-80								1nY 2					
	81-100												2qy 1	
With Rain														
Slightly cloudy	61-80			°1tC 1		1wC 1	1tC 3	1qC 1					2qC 1	
							1TC 1	1QC 5					2QC 1	
	81-100						1Tc 1							
Night cloudy, day clear							1tF 1							
							1TF 1	1QF 3					2QF 1	
	61-80	Oti 1		°1ti 1	°1QL 1		1ti 3	1qi 1						
Night clear, day cloudy	81-100			°1td 1	°1QI 2		1TL 2	1QL 3	1NL 1				2QL 2	
				OQi 1	°1TI 1	°1ql 2	1TI 5	1ql 1					2QI 1	
				Oqi 1	°1ql 2		1td 1	1QI 5	1ql 3					
Considerable cloudiness	61-80						1TT 1	1QT 2	1NT 1				2QT 1	
	81-100			°1										
				°1Qt 1			1Tt 2	1Qt 4	1Nt 2				2Qt 1	
				°1qt 1			1tt 1	1qt 3					2Qt 1	
Overcast	61-80							1QX 1						
	81-100							1qx 9	1nx 3				2qx 1	2nx 1

¹ From E. E. Fedorov, *A Complex Method in Climatology and Its Application to Agriculture*, State of New Jersey, Department of Agriculture Circular No. 207 (May, 1932), pp. 14-15. The number after each code group represents the frequency of occurrence of that weather type during the month of July over a ten-year period.

The "weather catalog" is a simple combination, for each recording station, of a series of cards, each of which represents the weather type for a 24-hour period. One such card is shown in Figure 1. On one side of the card are entered the name of the station and the date; on the other side, the weather information for that day. Thus, on the card shown, for 12 July 1939 in Moscow the weather is represented by the four letters *ZVDA*. The superscripts and subscripts are recent additions to the code representation, as stated above. Those ascribed to the second letter represent the maximum and minimum temperatures for the period. The superscript added to the third letter indicates the relative humidity at 1 p.m. The Cyrillic letters at the bottom of the card represent synoptic conditions for the day, and will be discussed later, under the concept of "complex-dynamic-climatological" analysis.

Fedorov experimented with many different kinds of tables and diagrams in an effort to effect a much needed simplification of presentation and to adapt his method to specific types of uses. In 1925 he introduced the graphic presentation shown in Figure 2 in an attempt to represent pictorially the normal January climate for Pavlovsk (now Slutzk, near Leningrad) and to compare the normal with the climate for two unusually warm Januaries, in terms of "climatic wholes," units that represent the weather complex for each day of the month. The weather element of first significance in this graph is the wind; first, velocity, and second, direction; and that is about the only element for which the character is immediately obvious from the graph. Information for the other elements is there in more or less precise form, but it must be gleaned by careful scrutiny of the graph. The graph, then, really serves the purpose of a shorthand method of recording (which might just as well have been accomplished in table form) and is not a visual aid in the sense that it enables one to grasp the mean or the distribution (in time) of the "climatic wholes" any more than a number of other forms of presentation might do it. This inclusion of all elements in maximum detail to the detriment of visual significance or mental "grasping of the overall" is a characteristic which runs through all of Fedorov's work.

Fedorov offered a new graphical presentation in 1927, Figure 3, which visually was

probably some improvement over his previous "wind rose" type of graph. However, it was still quite cumbersome and it did not make use of all the information in the weather card catalogs. Emphasis was shifted from wind velocity and direction in the graphs in Figure 2 to temperature and relative humidity in the graph in Figure 3. In fact, wind direction does not figure at all in Figure 3. Characteristics of certain other elements are more easily visualized in Figure 3 than in Figure 2, especially in Fedorov's originals of graphs such as that in Figure 3, which were in color.

These graphs were supplemented with tables, such as Table 2. Again the presentation is bulky and nonvisual. Also, there is a good deal of repetition between information supplied by the coordinates and that represented by the code figures in the body of the table. Not too much information would have been lost if only numbers representing frequencies of occurrence of coordinate categories had been presented in the table. Indeed, this has been done occasionally in similar tables by some of Fedorov's followers. The code symbols within the table add information only about diurnal amplitude of temperature and temperature change from preceding day—this by the second symbol, and, in case of significant precipitation, whether the precipitation fell before or after noon—third symbol. On the other hand, so many symbols clutter up the table that the frequency numbers are found and compared only with considerable difficulty.

At this point in his thinking, Fedorov states that the weather types should represent free states of the atmosphere. Therefore, such elements as wind, cloudiness, and precipitation are more valid indices than are dew, hoarfrost, diurnal range of temperature, etc., which are largely products of microclimatic influences. Mean temperature, he states, is a significant element in depicting weather types, although in it are incorporated both macro and micro climatic influences. But since, he says, it is so largely determined by wind, cloudiness, and precipitation, it might be considered that it had already been taken into account by a consideration of these three elements. Therefore, in distinguishing the weather types, temperature has been relegated to a secondary position. In Table 2 it is apparent that three levels of significance have been assigned, consciously or unconsciously, to the individual weather

elements as to their importance in depicting weather types. Of primary significance are wind and cloudiness, the two coordinate elements, and precipitation, which divides the table into two parts. Of secondary significance are mean temperature and relative humidity, which form subdivisions of the coordinates. And of tertiary significance are the elements represented only by the code figures within the table, diurnal range of temperature, change in mean temperature from the preceding day, and time of precipitation. In Table 2 elements represented by the fourth letter of the cipher code, condition of the ground surface and various phenomena within the atmosphere, have not been considered. The elimination of wind direction from this table is an indication of the preoccupation of the author with the effects of the wind on some nonclimatic factor, such as plant growth, which would ordinarily relate only to the velocity of the wind, rather than a concern with the effects of the wind on other climatic elements, a genetic relation which would correlate very significantly with the direction of the wind.

THE WEATHER CLASSES

The possibility and actual existence of so many weather types leaves one lost in a maze of different four-letter combinations in which one hardly ever encounters the same combination twice. Obviously, a grouping of types must be accomplished in order to effect comprehensibility. Fedorov intended that semi-unique groupings should be made to suit each use to which the complex method was put. But apparently this starting with the multitudes of weather types and simplifying them into a few groups defined for each specific purpose proved to be a too laborious preliminary manipulation for individual research studies. Therefore a somewhat standard definition of classes was evolved to serve as the basic grouping for all subsequent applications of the complex method. The grouping seems to have stabilized at a definition of 16 classes of weather, which rather suddenly appeared in print in various articles in 1949 without much explanation as to the thinking behind the decisions for these particular classes. In defining the 16 classes, Fedorov states simply that there are two bases for climatic classification (that is, for determining significant categories), genetic and applied (practical), and

since the genetic relations (causal correlations with types) have not been adequately investigated, he will use practical relations. One gets the feeling, through reading Fedorov's work, that he and others evolved these classes by a "sense of touch" of what was significant that was gained through studies relating weather types and plant growth phases. Yet, one can hardly justify the entire breakdown into classes on this basis, particularly the rather minute division of freezing weather, which usurps 6 of the 16 classes.

Following are the classes of weather types, listed in seasonal groups as they sometimes are shown. The numbering of the classes varies from article to article, although it appears that the order of listing has finally been standardized to facilitate "complex-dynamic" designations, which will be discussed later.

I. Warm season group

(Warm, dry subgroup)

1. Drought with hot, desiccating flow of air

2. Moderate drought

(Warm, moist subgroup)

3. Little cloudiness, not drought weather

4. Night time cloudiness

5. Daytime cloudiness

6. Rainy

7. Overcast without rain (dull, dreary day)

8. Humid tropical

II. Cold season group (Frost group)

9. Light frost (mean 24-hour temperature, 0 to $-2.5^{\circ}\text{C}.$)

10. Moderate frost (-2.5° to $-12.5^{\circ}\text{C}.$)

11. Significant frost (-12.5° to $-22.5^{\circ}\text{C}.$)

12. Strong frost (-22.5° to $-32.5^{\circ}\text{C}.$)

13. Hard frost (-32.5° to $-42.5^{\circ}\text{C}.$)

14. Extreme frost (below $-42.5^{\circ}\text{C}.$)

III. Transitional seasons (Thawing group)

15. Cloudy with temperature change across $0^{\circ}\text{C}.$ (advection thawing)

16. Radiation thawing (frost at night; occurs particularly in mountains and deserts)

Various boundary definitions for classes 1 to 8 have appeared in different articles, many of which allow for gaps and overlaps in the classification. The only complete and mutually exclusive definition of types into classes for the warm and transitional seasons groups has

been given in the form of a graph, which appears in Figure 4. A similar graph has been constructed for the cold-season group, but since these classes are defined by mean 24-hour temperature only, the graph is unnecessary and is not included here. The grouping of types into classes as shown in Figure 4 is quite arbitrary, and no justification for it has been offered. One surmises, from reading various of Fedorov's statements, that the classes have been defined to suit definite situations; that they are, therefore, highly subjective, somewhat fortuitous, and not necessarily universally applicable. All of the classes but one have been chosen because they are encountered within the borders of the Soviet Union; number 8 is a half-hearted attempt at taking care of the tropics, which lie outside the U.S.S.R.

Different classes are defined by noncommensurate weather elements; some by temperature, some by cloudiness, some by general dryness or raininess—unless one assigns a hierarchy of significance to the individual elements. Such an assigning, indeed, must have been made, although it has not been stated. A hierarchy of priority in approximately reverse order to the class numbering seems most likely to have been applied in a "cut-and-try" method of assigning weather types to weather classes. That is, in attempting to fit a weather type into its proper class one would first see if it fitted the conditions for class 16 and would work toward consecutively lower numbered classes until the right niche was found. Or perhaps the procedure was not so simple.

Some of the class designators are misnomers; number 6, for instance, does not include all rainy weather; numbers 4, 5, and 8 also include rain, with other qualifications added. Number 15, and even 16, might involve rain, although this possibility is not recognized in Fedorov's writing. And, of course, other forms of precipitation are possible in all the cold season classes. The system pays no attention to forms of precipitation other than rain. Isn't snowy weather significant? What about thunderstorms, hail, sleet, etc.? Obviously, in the cold-season group, temperature is considered to be of first importance, while in the warm-season group, rain takes precedence over the other weather elements, followed by cloudiness, and then temperature and humidity conditions. Can this particular assigning of levels

of significance to the different weather elements be justified on the basis of relation to plant growth? Is it significant to plant growth, or even to animals, whether the mean temperature of a winter day is -20°C . or -40°C .? Might not the amount of snowfall, depth of snow cover, or wind speed be just as significant, or even more so? Are so many cold-season classes warranted, based on any criteria?

It appears that the seasonal grouping is based on the subjective impression that these are the classes of weather that occur in these seasons, and it makes no difference what the magnitudes of temperature and other elements of the weather types are, so long as these types can be identified with seasons of occurrence. As is true all through the work of Fedorov and his followers, weather types and classes are grouped because they do in fact exist together in certain associations during a given season or in a given area, rather than grouped by objective criteria involving elements of their own make-up or genetic relations. The seasonal grouping is one of characteristic "weathers," whether these "weathers" are exclusive to the season, or even predominant in it. There is nothing to prevent a so-called "warm-season" type from occurring during the cold season, etc.

In developing presentations of space and time distributions of the weather classes, frequency of occurrence has become the byword. Frequency, not quantity, is the keynote that runs through all the work in "complex climatology," although all elements, except precipitation, have been defined quantitatively, within certain limits, in the original cipher code. Graphs, such as that shown in Figure 5, have become the standard medium for showing the yearly regime of the occurrences of the weather classes at any given point. Here a cross section is given showing the percent frequency of occurrence for each class of weather out of the total 100 percent occurrences during each month of the year. This is by far the most visually significant type of graphic presentation that has been devised by the proponents of the "complex method." As for showing areal distributions of these "weather" units, up to the present time the best that has been done has been the drawing of maps of isolines showing distributions of equal frequencies of occurrence of individual classes of weather

Lower Clouds	Precipitation	% Relative Humidity	Average 24-hour Temperature											
			f g h	c d e	z a b	w x y	t u v	q r s	n o p	k l m	j i j j	i i i j	f g h	c d e
			37.5 to 42.4	32.5 37.4	27.5 32.4	22.5 27.4	17.5 22.4	12.5 17.4	7.5 12.4	2.5 7.4	0.0 2.4	-2.4 0.0	-7.4 -2.5	-12.5 to -7.5
Little Cloudiness	Without Precipitation	0-20												
		21-40												
		41-60												
		61-80												
		81-100												
Daytime Cloudiness	Without Precip.	0-20												
		21-40												
		41-60												
		61-80												
		81-100												
Night time Cloudiness	Without Precip.	0-20												
		21-40												
		41-60												
		61-80												
		81-100												
Significant Cloudiness	Without Precip.	0-20												
		21-40												
		41-60												
		61-80												
		81-100												
Overcast	Without Precip.	0-20												
		21-40												
		41-60												
		61-80												
		81-100												

FIG. 4. Weather types without frost and weather types with early autumn frosts and thawing. From L. A. Chubukov, *Kompleksnaia Klimatologiya* (1949), p. 23. For an explanation of symbols representing classes of weather, see legend, Figure 5. ☒ represents combinations of weather elements that do not occur.

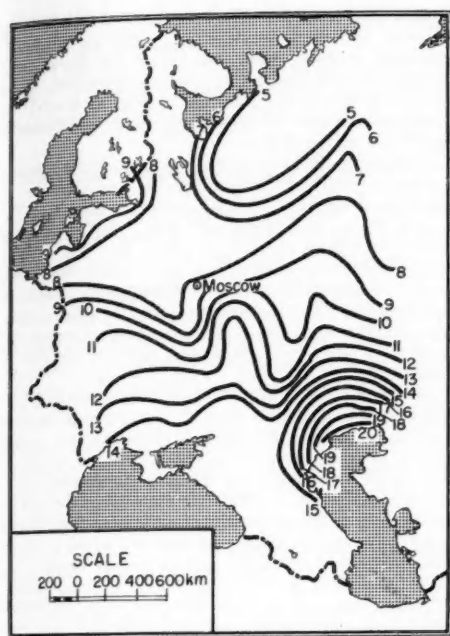


FIG. 6. Frequency of "Little Cloudiness, Not drought" weather in September, expressed in average number of days. Adapted from E. E. Fedorov and A. I. Baranov, "Klimat ravniny evropeiskoi chasti S.S.S.R. v pogodakh," *Trudy, Institut Geografii*, XLIV (1949) p. 171.

Fedorov and his followers, the weather types and classes are treated as if they were entirely independent entities. Yet, one cannot escape the fact that the 16 weather classes are related and gradational, that "rainy" and "overcast without rain" are classes that are more likely to be found in association than are "rainy" and "little cloudiness, not drought weather."

In Figure 8 one might question the right to simply connect boundaries from Figure 7, which were drawn using various criteria; particularly if the region thus enclosed does not encompass a group of related weather classes but is merely a meeting ground for unrelated classes from all sides. The names of the regions in Figure 8 are not climatic in nature but begin largely as topographic designators: "Western Dvina Basin," "Transvolga Uplands," etc., and defect to mere location designations: "Northern Ukraine," "Western Ukraine," etc. This terminology would seem to indicate the possibility of a good deal of preconception

about regionalization that could influence the drawing of highly subjective boundaries, as these are.

THE DYNAMIC ASPECT

The latest development in "complex climatology" has been the addition of a so-called "dynamic" aspect to the method. In 1946, L. A. Chubukov devised the method of recording data on the weather card catalogs that is illustrated by Figure 9. This was supposed to be a solution to the "climate genesis" problem which had bothered Fedorov and others for so long. Apparently, some such means of designating dynamic factors of climate had been put forth as early as 1935, by Fedorov himself, but no full and final expression was offered at that time. Actually, Chubukov's notations are nothing more than recordings of synoptic conditions associated with the weather type at the given place and time that the card represents. Chubukov uses the word "dynamic" much as the word "synoptic" is used in the United States. Such designations added to the weather card are merely recordings of synoptic conditions that have been determined by the use of daily weather charts, and their presence on the cards does not make additional allowance for new discoveries of dynamic or physical relations between given weather types and their causal factors over that that would have been possible with the materials at hand before the card notation was introduced. Such a notation does provide a record of weather types and respective synoptic conditions in juxtaposition with one another, which might serve as a convenient base of semi-statistical data for later analyses. But the addition of the so-called "dynamic" notation almost infinitely complicates the system of notation, which was unwieldy as it was. Indeed, it is not clear from any of Chubukov's writings just how he combines the "dynamic" notation with Fedorov's "weather type" notation. Whether or not all this information is entered on the original weather card is not clear. Apparently it is not; Figure 1 is apparently the form of the weather card notation that is used at the present time. The Cyrillic letters have been added at the bottom of the card to provide information about air masses, fronts, and positions with respect to pressure centers, but information involving sequences of weather observations is

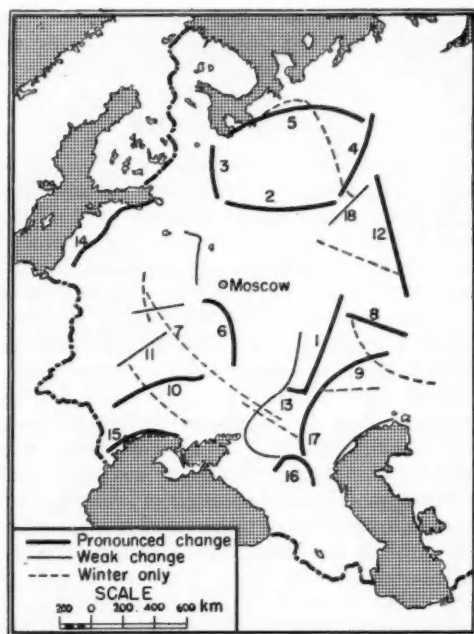


FIG. 7. Climatic boundaries on the European Plain of the U.S.S.R. Adapted from E. E. Fedorov and A. I. Baranov, "Klimat ravniny evropeiskoi chasti S.S.S.R. v pogodakh," *Trudy, Institut Geografii*, XLIV (1949), p. 214. These boundaries are based on bunchings of isolines of frequencies of various classes of weather, not on any one isolate. Fedorov says that the boundaries are based more on summer differences than on other seasons because of greater significance to activities of man. According to Fedorov, the numbered boundary lines as shown have the following significance:

1. Along the Volga from the confluence of the Kama to Stalingrad occurs an exceptionally clear demarcation in differentiation in frequencies of a series of classes of warm-season weather types (weather with *sukhovy*, general drought weather, weather with daytime cloudiness, rainy weather, and little cloudiness, not-drought weather). During the seasons of snow cover and thawing these differences are not so clearly marked. This boundary, of course, is tied in with the contrasts in surface conditions between the Volga Heights and the Transvolga region.

2. Line along the 59th or 60th parallel between 37°E and 50°E longitude. During the summer, to the north, there is great frequency of (1) rainy, (2) overcast, without rain, and (3) daytime cloudiness types of weather; infrequent "little cloudiness, not-drought" weather. In other seasons this boundary is not evident.

3. A little southeast of Lake Onega and along it to Onega Bay, from south to north; a clearly marked division between the basins of the rivers Onega and Northern Dvina and parts of the basins of Lakes

Onega and Ladoga. Here bunch together the isolines of (1) rainy weather, (2) rainy periods,* (3) overcast without rain, (4) little cloudiness, not-drought weather, and (5) daytime cloudiness. There is significance in the fact that here exists a rapid rise from west to east in the store of water in the form of snow towards spring.

4. East of 50°E longitude can be drawn a line projecting to the northeast toward the upper reaches of the River Pechora. It separates the basins of the rivers Onega and Northern Dvina, which in summer have great frequency of (1) rainy and (2) daytime cloudiness and low frequency of (1) little cloudiness, from the upper Pechora and Kama rivers, which are not so distinctly characterized. But in other seasons the division here is not marked. During winter, distributions can even be found opposite to that of summer.

5. In the north, approximately along the 56th parallel between 38°E and 55°E longitude, runs a boundary, a little less defined than Number 4, but which is continually discernible, based on the distribution of (1) rainy, (2) daytime cloudiness (not in all months), and, partly, (3) little cloudiness. Corroborating it also is the distribution of isolines on the map of time of disappearance of the snow cover, which south of 65°N occurs significantly earlier.

6. Along the eastern slopes of the Central Russian Uplands runs still another sufficiently clear line delimiting frequent weather of (1) rainy and (2) little cloudiness and partly weather of (1) daytime cloudiness.

7. Approximately along the western edge of the Central Russian Uplands can be drawn a separation, however not so clearly marked as in Number 6. Here exists a division in frequencies, mainly during the winter, of (1) warm weather* and, partly, (2) significant frost. Besides this, across this line towards the west is a rapid decrease in the length of winter. Less significance has weather in the warm seasons; only (1) daytime cloudiness gives important bunching of the isolines.

8. A very clear boundary runs from Samarskoi Luki along the River Samara. This boundary delineates frequencies of (1) *sukhovy*, (2) general drought weather, (3) rainy, and, partly, (4) little cloudiness, not-drought weather.

9. This boundary marks sharp changes in frequencies of weather with (1) *sukhovy*, (2) moderate drought, and (3) little cloudiness, not-drought between the Caspian Lowland and the Obshchii Syrt.

10. An ill-defined boundary cuts across the Ukraine approximately from Poltava and Luben to Uman' and Vinnitsa, delimited by frequencies in (1) *sukhovy*, (2) general drought, (3) rainy periods,* and (4) rainy weather.

11. Between the Poles'ye and the Northern Ukraine is found a boundary, oriented from northeast to southwest and corresponding closely to the isolines of frequencies of (1) moderate drought and (2) partly rainy weather.

12. Paralleling the Ural Mountains approximately at 55°E longitude runs a clearly defined division

* These are not among the sixteen classes of weather as defined by Fedorov and others.

apparently recorded separately in some other form. None of Chubukov's writings on the subject go any further than merely illustrating typical sequences of weather that do occur in selected regions of the Soviet Union.

PRACTICAL APPLICATIONS OF THE METHOD

The important adaptation of the "complex method" has been in the field of applied climatology, particularly in practical applications in the field of agriculture. At the outset, when Fedorov first formulated his cipher code in 1925, he stated that wherever decisions had to be made to decide for or against the inclusion of a given element or to decide the value intervals of various elements, the decisions were made to best suit the system to the uses of agriculture.⁵ Although the possibilities for applying the complex method in the fields of housing, construction, transport, and aeronautics have been mentioned several times in the literature, all articles written by Fedorov or by

⁵ Fedorov, *op. cit.*, fn. 3, p. 164: "In choosing one or the other different intervals for each of the individual elements, I have done so with the aim to simplify results and to work with least harm to accuracy with respect to practical applications in those sciences serving agriculture."

which is a reflection of the rapid growth in front of the Urals of frequencies in (1) rainy weather and (2) rainy periods, as well as in (3) moderate drought weather.

13. In the southern Volga Heights is found a short division (separating the southern extremities of these heights from the remaining parts of them), the situation of which (1) weather with sukhovy, (2) cloudy weather,* and (3) strong frost weather had a part in.

14. The boundary delimiting the maritime region extending along the shores of the Gulf of Finland and the Baltic Sea is distinguished by frequencies of (1) little cloudiness, (2) moderate drought, (3) daytime cloudiness, and (4) rainy weather.

15. The extremities of the southern Ukraine, along the Black Sea, are distinguished by frequencies of (1) moderate drought and (2) little cloudiness, not-drought weather.

16. North and east of the Stavropol Plateau are marked divisions formed by (1) sukhovy, (2) moderate drought, and (3) rainy weather types.

17. A sharply pronounced boundary defined by frequencies of (1) general drought, (2) sukhovy, and (3) partly rainy weather.*

18. A weakly pronounced boundary supported by distributions in frequencies primarily of (1) little cloudiness, not-drought weather.

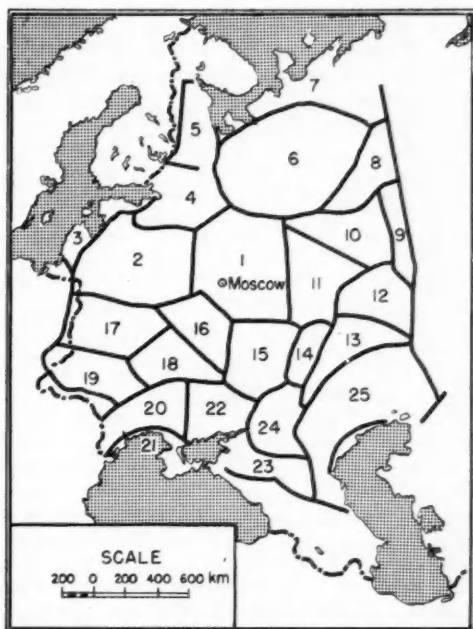


FIG. 8. Map of climatic regions. Adapted from E. E. Fedorov and A. I. Baranov, "Klimat ravniny evropeiskoi chasti S.S.S.R. v pogodakh," *Trudy, Institut Geografii*, XLIV (1949), p. 218. 1. Moscow and the upper Volga. 2. Western Dvina Basin. 3. Maritime region of the Gulfs of Finland and Riga and the Baltic Sea. 4. Leningrad and the great lakes. 5-8. Northern regions. 9. Central western foreland of the Urals. 10. Vyatka Basin. 11. Middle Volga and northern Volga Heights. 12. Transvolga uplands. 13. Transvolga meadows. 14. Southern Volga Heights. 15. Oka-Don Lowland. 16. Southern part of the Central Russian Uplands. 17. Poles'ye. 18. Northern Ukraine. 19. Western Ukraine. 20. Southwestern Ukraine. 21. Black Sea coastal lands. 22. Southeastern Ukraine. 23. North Caucasian foreland. 24. Lower Don. 25. Caspian Lowland.

any of his students that apply the complex method apply it to some phase of agriculture. Fedorov's only article published in English is his "Complex Method in Climatology and Its Application to Agriculture."

The application of the complex method to agriculture is somewhat analogous to the system used in the United States involving the concept of "growing degree days," in that certain phases of plant growth for given plant species are correlated with weather types, and predictions for crop successes or crop failures are based on totals of weather types expressed

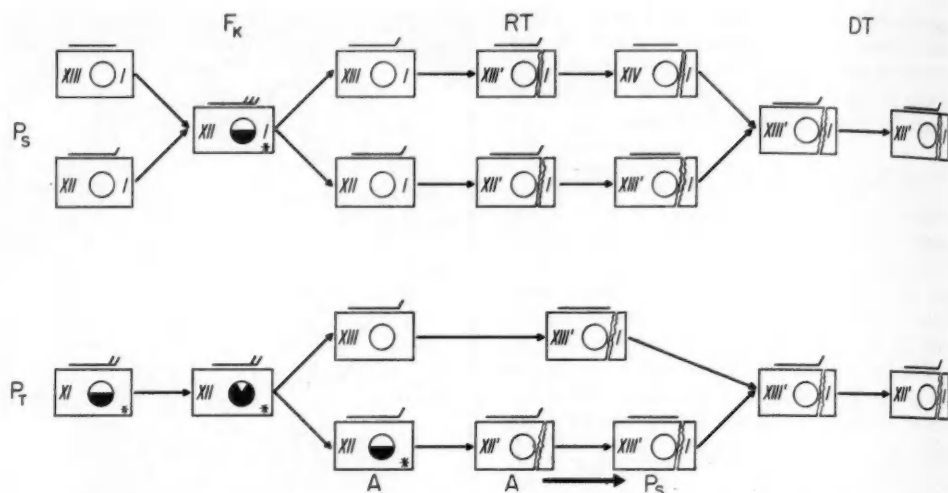


FIG. 9. Scheme of "dynamic-place" weather for Arctic intrusions in the region of Semipalatinsk. Adapted from L. A. Chubukov, *Novoe v Uchenii o Klimate*, Moscow (1949), p. 19. P_s , Polar Siberian air; P_t , Polar Turanian air; F_k , cold front; RT , radiation transformation; DT , dynamic transformation; $A \rightarrow P_s$, transformation from Arctic air to Polar Siberian air. Roman numeral, class of weather predominating for the day; index number ¹, lower temperature half of that class of weather—thus, temperature is given to 5°C. Symbols for cloud cover: ● 10/10; ○ night 6–10, day < 6; ○ night < 6, day 6–10; ● 6–10; ● < 6; ○ clear. Symbol, lower right: precipitation type. Wind arrow, showing strength only: barbs according to Beaufort Scale; without barbs, light winds; without arrow, calm. Relative humidity shown by symbol at far right of each box: A, 91–100%; 1, 61–80%; 2, 41–60%; 3, 21–40%; 4, 0–20%; 81–90%, not expressed.

in terms of growing time. Since Fedorov's weather types incorporate the totality of the weather affecting the plant, as he interprets it, rather than mere temperatures, as degree-days do, the complex method should be more suited to such applications and results should more closely approximate reality. Since no parallel testing of the two methods has been made, no statistical proof exists on one side or the other.

Fedorov has taken records of observations for various growth phases of several types of crops, particularly for rye and cotton, and correlated lengths of growth phases for individual years with types of weather existent during each growth period. By setting up equations

of the following type: $1 = \frac{a}{x} + \frac{b}{y} + \frac{c}{z} + \dots$,

where a, b, c, \dots represent the actual number of days of each weather type existent during the given growth period and x, y, z, \dots represent the number of days required for the growth phase of the plant in the event that the respective weather type prevails throughout the entire growth phase, and obtaining as many independent equations as there are weather types, the equations can be solved

simultaneously for all unknowns, x, y, z, \dots , and the theoretical number of days for a growth phase to be completed under each single weather type is then known. The recip-

rocals of these numbers, $\frac{1}{x}, \frac{1}{y}, \frac{1}{z}, \dots$, represent

the fractions of the growth phase accomplished by one day's existence of that respective weather type. Fedorov calls these fractions the "coefficients of connection." These coefficients expose the degree of favorableness of each weather type for each growth phase and can be added up for any combination of weather types to predict the length of a growth phase in a given area, for a normal growing season or for any given growing season.

Since the weather type is a rather precisely defined unit, over a period of years a great number of types occur during each growing phase. In order to simplify the solution of the simultaneous equations, the number of unknowns is reduced by grouping types into categories of favorableness, as is shown in Table 3. Here the years are listed from left to

TABLE 3.—TYPES OF WEATHER DURING CERTAIN PHASE OF RYE GROWTH IN SET OF YEARS, INDICATING FAVORABLENESS OF WEATHER TYPE TO GROWTH¹

(The types are grouped to join ones that are akin and of homogeneous significance)

Type of Weather	1912	1927	1911	1919	1924	1914	1918	1909	1917	1913	1923	1926	1928	1921	1925	1929	1916	1922	1915
	Duration in days—																		
	11	12	14	16	16	17	17	18	19	20	20	20	20	21	21	21	22	22	23
OZ-za	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
°1-lza	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..
lza	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..
OZA	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..
°1ZA	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..
°1za	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
lza	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..
2za	..	1	..	..	..	..	..	..	..	..	..	..	..	1	..	..	..	..	..
OW-wa-A	..	1	..	..	..	..	1	..	..	..	4	..	..	..	..	..	..	2	..
°1W-Wa-A	3	2	..	1	..	1	1	1	6	..	1	..	1	1	2	1	1	5	..
1W-Wa-A	1	..	..	1	2	4	..	4	1	2	1	..	..	1	4	..	1	2	..
OWA	2	..	..	..	1	..
°1W-wA	..	1	..	..	1	..	1	..	1	..	1	..	..	4	..	..	3	2	..
1W-wA	1	..	3	..	..	..	..	..	..	3	2	..	1	..	..
2W-wA	1	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	..
OT-Ta-A	..	3	2	2	..	1	2	..	1	1	..	..	4	..	..	2	..	..	..
°1T-Ta-A	..	1	2	2	1	4	2	1	2	1	..	..	5	1	..	..	2	..	4
1T-Ta-A	..	1	1	..	..	4	2	4	2	3	5	..	2	1	1	1	2	3	4
2t-Ta-A	1	..	..	..	..	..	1	..	..	..	1	..	1	1	..
O-°1TA	1	..	..	..	..	..	..	..	..	..	..	2	..	..	..	..	..
2tA	1	..	..	..	..	..
O-°1Q-Qa-A	1	..	1	..	4	..	..	..	..	..	..	1
1-2q-Qa-A	1	..	1	2	1	..	3	..	..	1	..	..	..	2
OW-wi-I	2	..	..	..	1	..	..	..	..	1	..	..	..
°1-lw-Wi-I	1	..	..	..	1	1	..	2	..
1tTi-I	1	..	..	..	..	..	..	..	..	1	3	1	2	2
O-°1q-QI	1	..	..	..	..	..	..	2
1q-qi-I	1	..	..	..	1	..	2	..	..	..	..	..	..	..	..	1
1tU	1	..	..	..
°1-2T-tU-u	1	..	..	1	..	..	1	1	..	1	2	..	1	1	..	..	..

¹ After E. E. Fedorov, *A Complex Method in Climatology and Its Application to Agriculture*, State of New Jersey, Department of Agriculture Circular No. 207 (May, 1932), p. 25.

right in order of increasing length in days of the particular growing phase, so that the shortest period, 11 days in 1912, falls at the left and the longest period recorded, 23 days in 1915, falls at the right. The weather types occurring most exclusively during the shorter growth periods must be the most favorable for that growth phase, and are listed at the top of the table. The degree of favorableness then de-

creases from top to bottom in the listing of weather types. The types listed at the top occur mainly during the years with shorter growth periods; their frequency numbers therefore lie in the left portion of the table. Those of intermediate favorableness are scattered throughout the years with some tendency to occur more frequently during the years with growth phases of intermediate

length. Those of least favorableness occur mainly in the longer periods. There is a tendency, then, for the frequency numbers to progress in the table from upper left to lower right.

Such a tabulation reveals the weather elements that do not significantly affect the particular growth phase, and the table can then be simplified by treating as identical those types that differ only in elements irrelevant to the growth phase under question. Just this has been done in Table 3 by combining, by a dash within types, two letters representing different values of the same element, the difference between the two values being of no significance to the growth of rye during its blooming-milky ripeness phase. Thus, in the first case listed, *OZ-za*, the *Z-z* indicates that it is immaterial to the plant in this growth phase whether these weather conditions are associated with a diurnal amplitude of temperature of 10.0-14.9°C. or with one of 15.0-19.9°C. Likewise, the second listing, *°1-1Za*, shows that it is immaterial whether the night was calm and the day was windy or whether there was a moderate wind all 24 hours.

The types are further grouped according to approximate degrees of favorableness, as determined by inspection of their occurrences within growth periods of differing lengths. Thus, Table 3, which is the refinement of a sequence of previous tabulations, shows only 13 categories of favorableness. These might be reduced in number even further, since some single-type categories, such as *2tA*, occur only infrequently. Generally, Fedorov, in his practical applications of the method to specific problems, has worked with no more than six or seven categories, since the computations become increasingly complicated with each additional variable.⁶

Again, one might enter a mild complaint against Fedorov for having considered weather types as unrelated entities which can be added up without regard to interdependencies among individuals. Certain it is that a plant responds

to sequences of weather types, not to just a weather type. Could warm, sunny weather be beneficial to a plant if there were no moisture in the soil, hence, no rainy weather preceding it? Nothing has been said about lag effects on plant growth of rapidly changing weather types. If these were to be taken into account, the computation would be immensely complicated. Also, a good deal of subjectivity must be involved in adjudging the beginning and end of a growth phase.

THE QUESTION OF CLIMATE GENESIS

Though the only real use of the complex method thus far has been in applied aspects of the field of climatology, it is evident, from reading his works, that two goals, two unattainable ideals, constantly have lurked in the back of Fedorov's head: (1) to work his weather types, as the basic units, into a really new and novel and universally workable climatic classification, and (2) to establish the connections between the weather types and their causal factors and to so construct his classification system that new genetic relations, previously undiscernible, inherently would be exposed. He seems to have intended that an establishment of these physical connections should be the ultimate act to be accomplished by him so that his complex method should become permanently incorporated in the procedure of climatic investigation. He seems to have maintained the proper perspective in viewing his accomplishments thus far in the light of the real goal, but always practical applications of the method presented themselves, and his time was consumed in such investigations. In defining his 16 weather classes he stated, almost wistfully, one feels, that there are two types of relations upon which one can base his categorizations of phenomena, genetic and practical, and since the genetic relations, in this case, have not been fully investigated, he will use the practical.

The only real flash of brilliance that Fedorov expressed in print, which might possibly have led toward either or both of these goals, was his concept of "fundamental weather types" (translated by him as "foundation" weather types),⁷ in which he envisioned basic weather types, real or unreal, characteristic of each locale, that would represent the total influences of the *Landschaft* and the local insolation balance, and would exclude the influ-

⁶ A fairly complete discussion of Fedorov's adaptation of the complex method to the study of growth phases of plants can be found in E. E. Fedorov, *A Complex Method in Climatology and Its Application to Agriculture*, State of New Jersey, Department of Agriculture Circular No. 207 (May, 1932), or, for those who read Russian, in a combination of papers, listed in the bibliography, dealing with certain aspects of crop growth.

ences of atmospheric advection.⁸ He starts out philosophically enough—in effect: “Do there exist fundamental types, real or otherwise, that represent the ultimate results under given sets of climatic controls, on the one hand shaped by the gross influences of air masses and circulation, on the other reflecting the characteristics of each private position?” This suggests the provocative thought that perhaps the ultimate in statistical classification is to define unreal weather types for ideal steady state or one-causal-factor conditions, and then to combine these abstract component parts to produce real “weathers.” These abstractions could provide a common denominator for adding up incommensurate real quantities or for comparing different stations whose real weather types are incomparable. Also, in the course of defining the fundamental types for each area, some hitherto unknown genetic relations might be revealed. But the ephemeral thread fades out, entirely, it seems, in a void of practical

incapabilities, and the concept is reconstructed in very rigid form in a regression to traditionalism, and he ends up defining the fundamental weather types as those types of weather that occur when the atmosphere next to the ground has adjusted to the local conditions of insolation-reradiation balance and the ground surface (topography, moisture, plant cover, etc.). Then he goes on to define characteristic fundamental types for various regions, and he correlates them with air masses. What he is doing, of course, is simply describing the “steady state” weather conditions that prevail after an air mass has stagnated in a region and has completed its modification to totally fit the surface over which it lies. The ideal fundamental types would, of course, only be achieved or closely approximated where the air stagnates for a time; that is, in an anticyclonic source region—in the Soviet Union, in southern Siberia and in the Turanian Lowland. In other regions of the Russian Plain

⁸ A word of caution must be inserted here against taking at face value English-language summaries that appear in Russian journals and are written by Russian authors. The translations are invariably strictly literal and involve the use of long participial and gerundive phrases, used attributively without punctuation, and English words with ambiguous meanings without regard to context. (For a sample of this, see last part of footnote 8, which has been quoted from an English-language summary of one of Fedorov's articles.) With regard to the title in question here, the Russian title reads: “Fundamentnye tipy pogody.” *Fundamentnye* is the nominative plural adjectival form of the word, and therefore should be translated as “fundamental,” not as “foundation.”

⁹ Perhaps this an oversimplification of Fedorov's concept; it is difficult to express his entire thought in words. His early writings on the subject seem to imply that his original thoughts incorporated some intangibles that he, also, was unable to express in words, so that when the formal statement was forced by publication, he settled for only a partial expression of his thought complex, the part that could be set down rather precisely in writing. Chubukov (*op cit.*, p. 57) states that Fedorov originally defined “fundamental type” as that type of weather that results from the “interactions of the conservative properties of an air mass with the influence of the landscape,” and that later the definition was refined, by him (Chubukov) and others, to fit the obvious fact that a fundamental type should be that type of weather that results or that would result at the completion of the modification of an air mass. Actually, Fedorov did not make the statement attributed to him by Chubukov, and his illustrative examples of how to distinguish fundamental types for actual localities in the Soviet Union indicate that he did have in mind that

the fundamental type was the resultant weather type after modification of the air overlying the region had been completed. The statement that Chubukov refers to is from E. E. Fedorov, “The ‘Foundation’ Weather Types: to the Problem on Climate Genesis,” *Trudy, Institut Fizicheskoi Geografii*, Vol. 14 (1935), pp. 10–11, and should read, “We see the central problem [of climate genesis] in the study of the interactions of the conservative properties of an air mass with the influence of the landscape.” Fedorov then goes on to attempt to illustrate that under clear, calm conditions a certain weather type does tend to evolve for each locale for a given period, no matter what the original air mass conditions, and he attempts to define the fundamental types for each area, by a very laborious computation, and he finally ends up by saying that the fundamental type is the final type that actually does exist after a long period of clear, calm weather. The real purpose of the above article is not particularly to define fundamental weather types but to illustrate how the influences of *Landschaft* can be separated out from total climate-forming factors. In his own English summary of his article, Fedorov states, p. 45: “Every climatic weather type must be regarded as a result of the interaction of air mass conservative qualities with the influence of the local landscape. In order to solve the problem of the weather type genesis, first of all, the question rises as to expression of the last influence. May any definite weather type, though really not observed, be determined which could be considered as the state of weather answering for this only influence? If an air mass would stay over a given locality, in which direction temperature, humidity, etc., in the lower layer should change, and would the weather come to the same definite type though approximately? This investigation attempts to answer the question, and to outline the result.”

these fundamental types are not attained. Fedorov says that they may never be attained. But he tries to define them for various regions anyway—the “unreal ideal” is lost; the “practical approximate” remains as a poor substitute, useful perhaps, but uninspired.

It seems as if the only weather types Fedorov really likes to identify are those that occur within air masses. What about the critical frontal zones? He talks about the uniquenesses of each private location; he would like to define the theoretical type that would correspond to the microclimatic conditions at each point on the earth's surface and then to add air masses to produce actual weathers. He seems, at this point, to conceive of weather types as being the result of solely (1) insolation balance, (2) circulation (air mass), and (3) surface conditions. He doesn't take account of the influences of mechanisms such as cyclonic storms. This thinking on the subject of climate genesis, which is primarily concerned with the microclimatic factors, is inconsistent with his earlier thinking when he first established his cipher code. At that time he stated that the weather types should represent states of the free atmosphere and should therefore be based largely on the macroclimatic elements, wind, cloudiness, precipitation, and the like, to the detriment of the more microclimatic elements, relative humidity, diurnal temperature amplitude, etc. Throughout his writing there is this dichotomy of thought which has not been adequately resolved; first he defines weather types according to a rather large set of criteria, some representing microclimatic controls, some representing macroclimatic controls, some incorporating aspects of both, as he himself says; then he holds constant certain of these criteria while comparing weather types at places separated by short distances in the hope of discovering certain genetic relations.⁹

CONCLUSION

Any classification involving a summing-up of immeasurable and/or noncommensurable items will quickly run into limitations after one has started from various points and described the fortuitous relations that exist as far as can be done in all directions, and then attempts to force these haphazardly divergent lines of development into common meeting points so that a relation which was identified for a par-

ticular situation (where it fitted perfectly, by definition) can be applied universally and carried to its ultimate. This forcing of a relation beyond its real limits to its theoretical ultimates reveals continually more inconsistencies the further each of the lines of reasoning is pursued. The more contradictions, the more arbitrary (perhaps subconscious) assigning of values, the more subjective the system, the less the same results can be obtained by two independent applicators.

Since Fedorov has carried his classification involving noncommensurable elements farther than anyone else has, his work turns up more inconsistencies and involves more unstated decisions with respect to the assigning of values in order to establish some boundary conditions, subjective though they may be. A study of his work might be worthwhile if only to illustrate difficulties encountered in this type of study and to offer some insight into partial solutions. At the present time, it appears that the fortuitous relations exposed to view by the invention of the complex method largely have been described, and, indeed, separate lines of reasoning have been pursued to the extent that a great many cross-points of contradiction have been encountered, and partially resolved by arbitrary and subjective rulings. The system of statistical manipulation has been refined and fairly stabilized, and applied and theoretical uses of the method have been tried, in some cases with partial success. For the past thirty-odd years the complex method has run its course of development, a period of time long enough, it would seem, to determine the extent of its significance and general acceptance. Where does it stand in the field of climatology today, in the Soviet

⁹ Since Fedorov's original diffuse inspirations on fundamental types have been defected into precisely defined mere shells of his original thought, no more belaboring of the idea will be done in this paper. For those who read Russian, some insight into his thought on the subject can be gained by reading E. E. Fedorov, "Fundamentnye tipy pogody," *Trudy, Institut Fizicheskoi Geografii*, Vol. 14 (1935), pp. 7-46; E. E. Fedorov, "Fundamentnye tipy pogody fiziko-geograficheskikh zon Evropeiskoi chasti SSSR dlia letnego polugodiia," *Izvestia Akademii Nauk SSSR, Seriya Geograficheskoi i Geofizicheskoi*, No. 1 (1937); and E. E. Fedorov and A. I. Baranov, "Klimat ravniny Evropeiskoi chasti SSSR v pogodakh," *Trudy Instituta Geografii*, Vol. 44 (1949), pp. 107-26. Chubukov accords "fundamental types" a discussion of only one and one-half pages out of the 94 total pages of his *Kompleksnaia Klimatologiya* (1949).

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Union and in the world? Outside the Soviet Union it is still little known. Within the Soviet school of climatologists it seems to hold a very minor, if not a negligible, position. Its advocates consist of a few hard-core adherents who would sell the complex method to the exclusion of all other climatological methodology. All other Soviet climatologists have made note of its existence as an interesting phenomenon and then have gone on their merry ways along more traditional lines of climatic investigation. So, it is not a matter of partial acceptance by the entire Soviet school, but one of complete acceptance by a small fraction of the school. Some recent Soviet texts on climate have mentioned Fedorov's work, not derogatorily, but impassively, as an adjunct to the main textual material, just so the books would be all-inclusive.¹⁰ None of the complex method is embodied in the textual materials themselves. Ryzhkov, in summarizing climatological developments for the entire Soviet period, mentions Fedorov's work as being of high caliber and a case where some of the theoretical aspects of climatology have been tackled, but he does no more than to mention it.¹¹

It seems that the weight of opinion of the majority of the Soviet climatologists has forced a swing of the pendulum of enthusiasm of the "complex" school of thought back to a more normal position at some median point between the extremes reached by the advocates of the complex method in the 1930's and the traditional methods of climatological study. Thus,

¹⁰ The two basic texts on climatology for university students in geography and meteorology in the Soviet Union at the present time are A. A. Borisov, *Klimaty SSSR* (Moscow, 1948), and B. P. Alisov, O. A. Drozdov, E. S. Rubinshtein, I. A. Berlin, and V. M. Mikhail', *Kurs Klimatologii*, in three parts (1952 and 1954). Fedorov's method is briefly explained on pages 465-68 in *Kurs Klimatologii* in the part dealing with different systems of classification, but is not used or mentioned in Part III, which deals with the distribution of climates over the world. Borisov does not mention Fedorov's work. A text for hydrometeorological technicians, S. I. Kostin and T. V. Pokrovskaya, *Klimatologiya* (Leningrad, 1953), contains about a two-page resumé of the complex method, but makes no use of it. In another book, Alisov (B. P. Alisov, *Klimaticheskie Oblasti i Raiony SSSR* [Moscow, 1947]) makes no mention of Fedorov. Regional climatologies, such as P. T. Smoliakov, *Klimat Tatarii* (Kazan', 1947) and A. I. Kaigorodov, *Klimat BSSR* (1933-34), make no use of Fedorov's method.

¹¹ Cmdr. K. P. Ryzhkov, *Soviet Climatology for 30 Years*, U. S. Weather Bureau Seminar Talk, planogr. 16 pp., April 7, 1948.

whereas in the beginning Fedorov unequivocally denounced analyses using mean data of individual weather elements, in 1949 Chubukov, at present undoubtedly the most vociferous proponent for the complex method, stated: "The expression of climate in terms of 'place' weather, of course, does not exclude utilization of analyses of many-year regimes of individual meteorological elements and phenomena. . . ."¹² This concession to traditionalism is made, apparently with reluctance, in the face of opposition to total acceptance of the complex method by the majority of Soviet climatologists and in the face of the impossibility of the complex method's achieving the ultimate expressions that any adequate methodology must provide for. This statement is only lip service to the majority, and Chubukov does not bother to make it in his other summaries of the complex method, which he has written from time to time, often in a semi-popular vein, to deliver to certain groups of people.

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¹² Chubukov, *op cit.*, pp. 8-9.

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- continental tropical air masses in summer on the way from southeast and south to Moscow), *Akademiia Nauk SSSR, Trudy Instituta Geografii, Voprosy Klimatologii*, Vol. 48 (1950), pp. 71-87.
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RIBBON DEVELOPMENTS IN THE URBAN BUSINESS PATTERN

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THIS paper serves two purposes. First, it contains a review of the research methods and the findings of several recent studies of urban business.¹ These studies provide new information concerning the urban business pattern, including a classification of business types and shopping centers. Second, the paper contains an application of the classification of business types developed in the works reviewed to the study of business establishments located in ribbons along major arterial highways. Both intra- and inter-urban ribbons are analyzed. Results of the analysis suggest the persistence of similar spatial patterns of retail and service business both within and between cities.

Both purposes have many general implications. New information is provided concerning aspects of urban business activity little studied by geographers. There is opportunity for further review of central place theory in new empirical situations. Evidence is provided in light of which current planning and zoning for urban business may be evaluated. Immense investments in new highway systems are at present being undertaken. Findings facilitate informed discussion concerning the reorganization of business life such investments will call forth.

One of the most frustrating problems to confront students of urban business has been to describe, to classify, and to analyze objectively the various patterns of concentration and dispersion that are characteristic of business establishments located in ribbons along arterial highways. It is here that the paper makes some small contribution. Groups of spatially associated business types described in the first half of the paper are shown to have meaning in the ribbon context. This information facilitates the testing and verifi-

cation (albeit graphically) of hypotheses concerning areal patterns of business types located along arterial highways. Conclusions are strong enough to generalize about the spatial structure of ribbon business, and to show how this structure relates both to wider systems of business within urban areas and to business in the urban hierarchy.

SUMMARY OF RECENT STUDIES

The first study of urban business which is of interest here was conducted in Spokane, Washington.² It was in this study that research methods were developed and first tentative generalizations were made. The Spokane study was duplicated in Cedar Rapids, Iowa. Subsequently, investigations were undertaken with data available for the cities of Cincinnati, Ohio, and Phoenix, Arizona. Use was also made of data concerning a sample of planned shopping centers throughout the United States, and of an inventory of business located along U. S. Highway 99 between Seattle and Everett, Washington.³ The U. S. 99 data are discussed in more detail in the second part of this paper. As these studies were conducted many of the generalizations made in the Spokane study were confirmed or modified.

Motivation and Hypotheses

Motivation for the studies came from frequent assertions that recognizable types of shopping centers and business districts could be identified within cities, yet an apparent inability of any student to derive empirically patterns of functional association which could be closely related to the asserted types of centers.⁴ Also, the pattern of shopping centers predictable from central place theory (i.e., a structured step-like hierarchy) was not suf-

¹Detailed discussions of these studies are contained in Brian J. L. Berry, "Shopping Centers and the Geography of Urban Areas" (unpublished Ph.D. thesis, University of Washington, 1958), and William L. Garrison, Brian J. L. Berry, Duane F. Marble, John D. Nystuen, and Richard L. Morrill, *Studies of Highway Development and Geographic Change* (Seattle: University of Washington Press, 1959, in press).

²Berry, *op. cit.*

³The Cedar Rapids and subsequent studies are recorded in Garrison, Berry, *et al.*, *op. cit.*

⁴A sample of such earlier studies of urban business includes Inez K. Rolph, *The Locational Structure of Retail Trade* (Washington: U. S. Bureau of Foreign and Domestic Commerce, Domestic Commerce Series, 1929); R. U. Ratcliff, "An Examination into Some Characteristics of Outlying Retail Nucleations in

ficient to account for the entire set of types suggested in earlier empirical work, and this presented additional problems. Further motivation was more practical. Immense investments are now being made in the new system of Federal Interstate and Defense Highways, in addition to continuing and expanding state and local investments in highways. The Congress of the United States has asked the Bureau of Public Roads to report on the economic effects of such highway improvements. The author was one of a group at the University of Washington which analyzed for the Bureau various aspects of the economic and geographic impact of new highway construction, and in particular was concerned with the effects of highway development upon patterns of urban business. Before any information could be provided about effects of highway change upon the economic complex, however, the present structure of the system had to be known. Precise and detailed information had to be obtained concerning patterns of urban business.

From central place theory and from previous empirical works it was hypothesized that urban business types fell into orderly hierarchical patterns of shopping centers and business districts. Further, it was hypothesized that these patterns were the product of the areal grouping and dispersion characteristics of the individual stores and business types. The Spokane and subsequent studies were designed to test these hypotheses and thereby to clarify the structure of urban business.

Data and Research Design

In the Spokane study some 60 business types were identified (for example, drug store, barber shop, department store). The number of stores in each of these types was recorded for every business center in the city except the central business district. Accumulation of these data involved going into the field both to delimit each center and to take the census of business. Ranging in size from the ubiquitous street-corner grocery or general

store to the large regional shopping center, 296 business districts were found within the legal limits of Spokane. Each of these was visited to obtain necessary information for the study.

To collect data for Cedar Rapids an initial delimitation of business centers and census of stores was made using the Polk City Directory.⁵ This was supplemented by later field check. Data were already available in published form for Cincinnati and Phoenix.⁶

Analysis of these data was accomplished in the following stages:

(1) Each shopping center was treated as an observation. For each observation 60 characteristics were recorded, namely the number of stores in each of 60 business types. Thus, for an isolated street-corner grocery the recorded characteristics were a "1" in the grocery cell, and zeros in the cells associated with all other business types. As centers grew in size the cells were filled out and the number placed in each cell was adjusted accordingly. Observations were then prepared for statistical manipulation. High-speed electronic computers were used for the numerical analysis, for processing a data matrix of size 296×60 would have been impossible using less than the most efficient means available.

(2) Each business type was correlated with every other type. In Spokane this involved computation of more than two thousand correlation coefficients.⁷ Each correlation coefficient indicated the similarity of the pattern of occurrence of a pair of business types in the set of shopping centers.

(3) Correlation coefficients were arrayed in matrix form, and to this matrix linkage analysis was applied to obtain groups of busi-

⁵ Polk directories are published for most of the major cities of the United States by R. L. Polk and Company. The Cedar Rapids study was undertaken by John D. Nystuen.

⁶ W. Applebaum and B. L. Schapker, *Atlas of Business Centers. Cincinnati-Hamilton County, Ohio* (Cincinnati: The American Marketing Association, 1955); First National Bank of Phoenix, *Shopping Centers in Greater Phoenix, Arizona* (Phoenix: First National Bank of Phoenix, 1957).

⁷ But for the grant of ten hours of free time upon the I.B.M. 650 digital computer of the Western Data Processing Center of the University of California, Los Angeles, this part of the research (and therefore the whole undertaking) would have been of marginal feasibility. The author wishes to express his thanks for the assistance which WDPC gave him.

Detroit, Michigan" (unpublished Ph.D. thesis, University of Michigan, 1935); M. J. Proudfoot, *The Major Outlying Business Centers of Chicago* (Ph.D. thesis, University of Chicago, 1936); William L. Garrison, "The Business Structure of the Consumer Tributary Area of the Fountain Square Major Outlying Business Center of Evanston, Illinois" (unpublished Ph.D. thesis, Northwestern University, 1950).

ness types with similar location habits as defined by the correlation coefficients.⁸

(4) Given the derived groups of business types, the larger matrix of correlation coefficients was reduced to a summary matrix of average intergroup correlations. Linkage analysis was again applied to study the association of groups of business types in larger conformations.

(5) Information was now available concerning groups and conformations of spatially associated business types. It had previously been hypothesized that orderly patterns of shopping centers and business districts were the outcome of areal grouping and dispersion characteristics of individual stores and business types. Therefore original observations of numbers of stores by business type within shopping centers were retabulated and listed, thus reorganizing the data on the basis of groups and conformations of business types. Again, this was a relatively speedy and simple process using available data-processing machines. Examination of the resulting retabulations was sufficient to verify the hypotheses, as indicated by the "examples" section of Table 1.

Findings

As a result of the studies, four conformations of business were recognized, together with constituent groups of business types and the business districts or functional areas they create. These conformations are: the nucleated shopping center type, urban arterial business districts, highway-oriented business districts, and automobile row. Table 1 summarizes these conformations, groups, etc., and gives representative examples of resulting centers and districts, selected from the Spokane data. Each conformation is discussed below.

Regular shopping trips from the household for goods and personal services focus upon three levels of nucleated shopping center, in addition to ubiquitous isolated general stores or groceries. It is implicit, of course, that these levels lie below that of the central busi-

TABLE 1.—TYPES, GROUPS, AND CONFORMATIONS OF BUSINESS WITH RESULTING FUNCTIONAL AREAS, BUSINESS DISTRICTS, AND SHOPPING CENTERS

Business types grouped	Associated type of center or district	Spokane examples ¹					
		A	B	C	D	E	F
<i>(a) Nucleated Shopping Centers</i>							
General Store		-	-	-	-	-	-
Grocery		1	1	2	-	-	-
Barber	Neighborhood shopping center	1	2	4	-	-	-
Cleaners/laundry		1	3	3	-	-	-
Drugs		1	2	2	-	1	-
Hardware		1	1	3	-	1	1
Beauty		-	1	2	-	-	-
Bakery		-	-	1	-	-	4
Real estate and insurance		1	2	7	-	5	1
Variety	Community shopping center	-	1	2	-	-	-
Clothing		-	5	6	-	-	-
Dairy		-	-	1	-	-	-
Lawyer		-	5	2	-	-	-
Jewelry		-	1	2	-	-	-
Post office		-	1	1	-	-	-
Department		-	2	1	-	-	-
Shoes	Regional shopping center	-	1	2	-	-	-
Sporting goods		-	-	1	-	-	-
Bank		-	-	1	-	-	1
Professional offices		-	-	1	-	-	1
<i>(b) Highway-Oriented Facilities</i>							
Gas		-	3	5	3	7	3
Restaurant	Automobile service districts	-	1	5	2	5	-
Motel		-	-	-	-	-	-
Fruit and produce stands		-	-	-	-	3	1
Building services and supplies		-	-	4	-	1	1
Lumber yard	Space-consuming service districts	-	-	1	-	-	-
Miscell. repair incl. plumbing		-	-	1	-	-	-
Radio-TV sales and service		-	-	-	-	1	1
		-	-	-	-	1	1
<i>(c) Urban Arterial Districts</i>							
Auto repair		-	-	1	2	2	-
Bars		-	-	3	2	1	1
Shoe repair		-	-	1	-	-	-
Furniture	Urban-arterial oriented	-	-	4	1	1	-
Auto accessories		-	-	1	-	1	-
Appliances		-	1	3	-	-	1
Fuel		-	-	-	-	-	-
Gift and novelty		-	-	-	-	1	-
Food lockers		-	-	1	-	1	2
Florists		-	-	1	-	1	2
Printing		-	-	-	-	1	-
Office equipment and supplies	Arterials close to CBD	-	-	-	-	-	1
Funeral homes		-	-	-	-	1	-
Missions		-	-	-	-	-	-
Second-hand stores	"Skid-row"	-	-	-	-	-	-

⁸ Linkage analysis is discussed in Brian J. L. Berry, "A Note Concerning Methods of Classification," *Annals, Association of American Geographers*, Vol. 48 (1958), pp. 300-303.

TABLE 1.—(Continued)

Business types grouped	Associated type of center or district	Spokane examples ¹					
		A	B	C	D	E	F
<i>(d) Automobile Row Functional Area</i>							
New auto sales		-	-	-	-	-	8
Used auto dealers		-	-	-	-	1	8

¹ Spokane examples are as follows:

- A Neighborhood shopping center
- B Planned community shopping center
- C Large unplanned regional shopping center located at major highway intersection
- D Minor urban arterial district
- E Urban arterial district along major highway
- F Automobile row

Numerals indicate the number of stores.

ness district of the regional metropolis,⁹ which is itself described by the pattern of nucleation. By conventional usage, the three levels are termed "neighborhood," "community," and "regional" shopping centers. The names are descriptive of the areas served by each. Such nucleated centers may be analyzed effectively using central place theory.¹⁰ Functions performed at each of the levels of the hierarchy are defined in Table 1. Nucleated centers are located centrally with respect to their trade areas. Distance from any center to centers of similar rank is a function of the orientation and quality of transport facilities and of the density of distribution of purchasing power. Where purchasing power per unit area is relatively great, centers are closely spaced, as within the continuously built-up areas of cities. Where purchasing power is more sparsely distributed centers are more widely spaced, as in suburban areas. The pattern continues into the open countryside, where nucleated centers constitute the central places to which central place theory has normally been applied.¹¹

⁹ Defined as a city central to a large regional market. Thus Spokane is recognized as the center of the "Inland Empire." Central business districts of smaller cities, towns, and villages have the functional character of lower order nucleated shopping centers within the metropolitan area of the regional metropolis.

¹⁰ Brian J. L. Berry and William L. Garrison, "Recent Developments of Central Place Theory," *Papers and Proceedings*, Regional Science Association, Vol. 4 (1958), pp. 107-20.

¹¹ Brian J. L. Berry and William L. Garrison, "The Functional Bases of the Central Place Hierarchy," *Economic Geography*, Vol. 34 (1958) pp. 145-54. There is one qualification. That is that central places outside metropolitan areas are also nuclei in which "urban arterial" functions locate. Too, seldom is any nucleation free of all types of highway-oriented facilities.

Highway-oriented facilities are either located with respect to a set of demands occurring spatially as a flow along highways, not associated with demands for nucleated shopping facilities, or they are business types which require large and expansive sites and ready access. Traffic moving along arterial highways generates a set of demands for gasoline, for restaurant facilities, for motels, for fruit and produce. These demands are satisfied by stores oriented to the highways. Generally, the greater the traffic flow along a highway, the greater the number of highway facilities in "automobile service districts" paralleling the highway. Functions providing household supplies and repair facilities require locations convenient to the person who makes an infrequent special trip to visit them, or convenience for ease of loading and unloading and for delivery to or service at the home. At the same time these supply and repair activities need large amounts of space at low rent. Therefore they also seek accessible highway locations outside higher-rent nucleations. Along the highways, they either mingle with automobile service facilities or are found in their own special districts.

Urban arterial business districts result from the spatial association of types of business which seek out urban areas, but which within urban areas are apparently most successful when located along urban arterial highways.¹² This situation contrasts with nucleated functions which concentrate within urban areas, and highway-oriented facilities which seek out major traffic arteries, apparently indifferent to whether these arteries are located within or between urban areas. Automobile repair is an urban arterial function found from the village level up, as is the bar where local legal conditions permit. As the size of center increases, additional members of the group appear. In regional metropolitan centers arterials immediately adjoining the central business district

¹² Success is here inferred from the observable fact that such business types persist in urban arterial locations and are absent elsewhere. Likewise, it may be inferred that highway-oriented functions are most successful when located along major highways, and that nucleated functions are most likely to be competitive, and therefore successful, when located in nucleated shopping centers. This argument is strengthened by information concerning locational trends in the various business types incident upon highway change. See Garrison, Berry, et. al., *op. cit.*

are characterized by additional establishments providing printing services, office equipment, and office supplies. Such large cities will usually also have a "skid row" with its concentration of bars and missions, second-hand stores, loan and pawn shops, and flophouse hotels. Skid row frequently has an arterial location, in the low-rent "zone of discard" away from which the central business district is migrating.

Larger cities also have one or more specialized functional areas with concentrations of dealers in new and used automobiles. This is termed "automobile row."

The four conformations of business are mutually exclusive as functional groups, but they need not be spatially exclusive. Examples from Table 1 will indicate this. The large regional shopping center (C) includes, for example, highway-oriented and urban arterial functions where the locational requirements of these conformations coincide, at the intersection of two major arterial highways, with the locational requirements of the nucleated business types. Likewise, the large urban arterial district (E) has drugstores, real estate and insurance agencies. Automobile row (F) has its barber shop. Conformations and constituent groups of business types thus develop because certain types of business regularly locate together and assume identifiable spatial patterns. The second part of this paper illustrates how this information concerning frequencies of association and spatial patterns may be used to analyze business ribbons.

ANALYSIS OF RIBBON BUSINESS

Of the studies of business undertaken prior to those discussed in the previous section of this paper, the works by Rolph, Proudfoot, Ratcliff, and Garrison have already been mentioned.¹³ That by Merry has not.¹⁴

In the former studies discussion of ribbon business is set within consideration of the entire business structure of the city. The con-

sensus is that string-streets (business ribbons) are highly specialized forms of development along traffic arteries, with automobile facilities and furniture, household and general merchandise functions most in evidence. Proudfoot observes that as business streets ribbons possess widely spaced convenience and shopping goods stores and as traffic arteries they serve mass vehicular traffic. Ratcliff describes string-streets in terms of businesses located along traffic arteries but rarely down intersecting streets. He says that the nature of these businesses depends upon the extent to which the street is a main traffic artery and the degree to which it is the core of a residential area. Functions which serve residential areas appear as nucleated "beads" set within string-street developments. Garrison identifies ribbon business types as: fuel dealers, automobile servicing firms, eating establishments, automobile dealers, recreational establishments, and suppliers of building materials. He recognizes that ribbon businesses frequently occupy expansive sites and do not rely upon comparison shopping as a prerequisite for sales.

Merry studied a single business ribbon: East Colfax Avenue, Denver, Colorado. Main features of his work are an analysis of the location habits of business spread along the highway, and suggestions of relationships between certain business types and traffic volumes, direction of traffic flow, and extent of immediate residential neighborhoods. A sample of the findings may be outlined. Density of stores diminishes with increasing distance from the central business district of Denver, although there are marked variations in density, with peaks at major intersections. Traffic volumes are greater inbound, and on this side of the highway are relatively more gas stations and automobile dealers. Population density is greatest in a three-block strip parallel to outbound traffic, and on this side of the ribbon are relatively more beauty shops, bakeries, groceries, taverns, and hardware

¹³ See footnote 4 above.

¹⁴ Paul R. Merry, "An Inquiry Into the Nature and Function of a String Retail Development. A Case Study of East Colfax Avenue, Denver, Colorado" (unpublished Ph.D. thesis, Northwestern University, 1955). For other studies of business along highways see Andreas and Lois Grotewold, "Commercial Development of Highways in Urbanized Regions: A Case Study," *Land Economics*, Vol. 34 (1958), pp. 236-44;

E. Eiselen, "The Tourist Industry of a Modern Highway: U. S. 16 in South Dakota," *Economic Geography*, Vol. 21 (1945), pp. 221-30; J. M. Roberts et al., "The Small Highway Business on U. S. 30 in Nebraska," *Economic Geography*, Vol. 32 (1956), pp. 139-52; W. G. Faithfull, "Ribbon Development in Australia," *Traffic Quarterly*, Vol. 13 (1959), pp. 34-54.

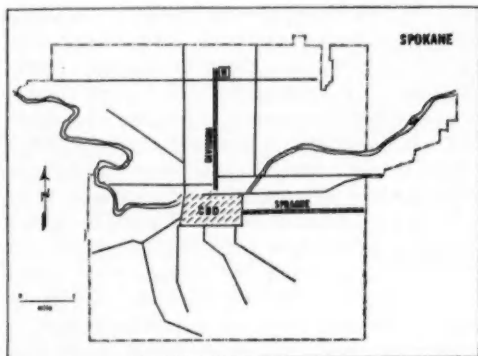


FIG. 1. Study areas in Spokane, Washington. Division Street north from the central business district to Northtown shopping center, and Sprague Avenue east from the central business district to the city limits. Northtown is indicated by N.

stores. Stores agglomerating in high-density zones include beauty and barber shops, grocery, clothing, shoe, hardware, and dry goods stores, florist shops, and bars. Low-density zones are more frequently occupied by automobile dealers, automotive repair, gas, chain grocery, creamery, and ice cream facilities. Showing little tendency to concentrate either in high- or low-density zones are restaurants, cleaners and laundries, and furniture stores.

No generalizations concerning ribbon business were produced by these studies. However, it is hoped that the bases of much needed generalizations may be provided by combining findings of these earlier works with information concerning groups and conformations of business developed in the Spokane and associated studies, and by using this larger body of information to interpret and analyze business ribbons. Two cases will be studied: the Sprague Avenue and Division Street ribbons in the city of Spokane (Fig. 1), and the 25-mile ribbon of business along U. S. Highway 99 between Seattle and Everett, Washington (Fig. 2). In Spokane data used involve counts of business establishments by type in successive city blocks; along U. S. 99 business establishments are counted in successive one-eighth mile units.¹⁵

¹⁵ The author is indebted to Mr. Alexious Shakar for tabulation of these U. S. 99 data in his work for the Snohomish County Planning Commission, and for permission to make use of them in this study.

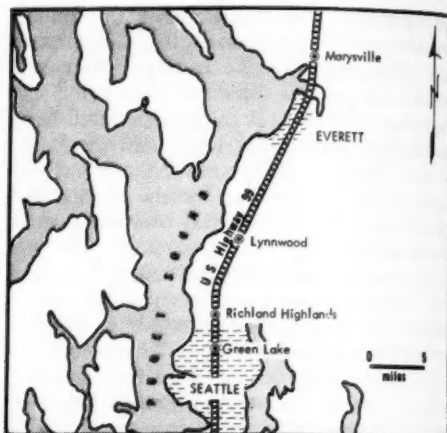


FIG. 2. U. S. Highway 99 study area. Extends north 25 miles from 65th Street in Seattle to within the city limits of Everett, Washington.

The Urban Arterial Case

Figures 3 and 4 illustrate graphically how business types locate within groups, block-by-block, along Sprague Avenue east of the central business district and along Division Street north of the central business district in Spokane, Washington. Table 1 records the types of business within the groups. Only one urban arterial group is recognized, within which are placed all urban arterial business types.

Grouping and dispersion characteristics may be determined by comparing vertical and horizontal patterns of occurrence of establishments within groups in Figures 3 and 4. Along Sprague Avenue, for example, discontinuous vertical patterns identify nucleated shopping centers. Thus, shopping centers are found at A and B in Figure 3. A is a regional shopping center. B is a small neighborhood center. The hierarchical rank of nucleated centers may be determined quite readily by examining the functional groups locating in the centers.

In marked contrast to the vertical patterns created by shopping facilities nucleating in limited areas are the horizontal dispersors of urban arterial and highway-oriented facilities, spread along the length of the highway. Radio-TV and miscellaneous repair types include several shades of functional specialization, and this accounts for what might otherwise seem to be a concentration of space-consuming functions in the regional nucleation

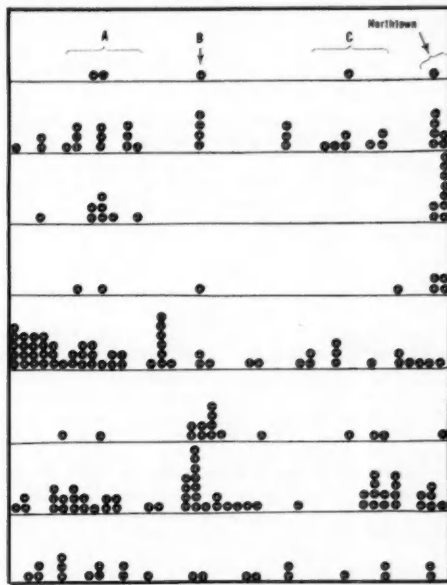
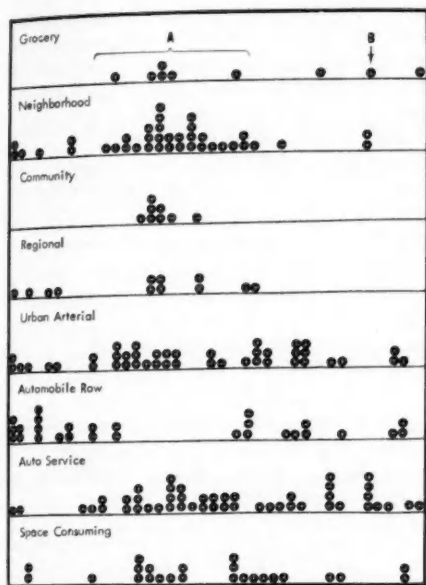


FIG. 3 (left) and FIG. 4 (right). Distribution of business types within groups along Sprague Avenue and Division Street, respectively, in Spokane. One dot represents one business establishment. Data were compiled by the author in the field. Along Sprague Avenue A represents a large unplanned regional shopping center and B a smaller neighborhood nucleation. On Division Street A is a community-level center, and B and C are neighborhood centers. The highly nucleated Northtown center stands out clearly, and the hierarchical rank of this planned center is evident. Note that business types are plotted by location within a city block, regardless of side.

(A). This concentration includes a "fixit" shop and an establishment devoted to sales of radios and television sets, neither of which are space-consumers, but both of which are classified "urban arterial."

Sprague Avenue is also characterized by an extension of Spokane's major automobile row east from the central business district. This results in sprawls of dealers in new and used automobiles along the highway. But note the absence of automobile row facilities in the regional nucleation A.

Division Street data show vertical and horizontal patterns similar to those observed along Sprague Avenue (Fig. 4). Vertical trends indicate nucleations, as with the unplanned community center A and the planned Northtown shopping center. Smaller neighborhood nucleations are also to be seen, as at B and C.

Horizontal trends again characterize urban arterial and highway-oriented groups. Division Street is less densely developed than Sprague Avenue. This more sparse develop-

ment means greater availability of space, and it is reflected in the greater spread of space-consuming highway-oriented functions. A

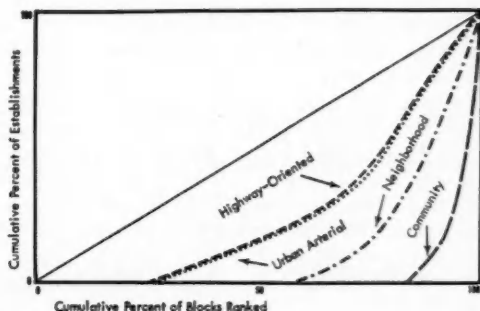


FIG. 5. Lorenz curves plotted for four groups of business types using Division Street data. City blocks are ranked from those with least business establishments at left to those with most at right on the abscissa. The ordinate records the cumulative percent of establishments in these ranked blocks. Note the identity of curves for the highway-oriented and urban arterial types, and the increasing concentration of higher level nucleated centers.

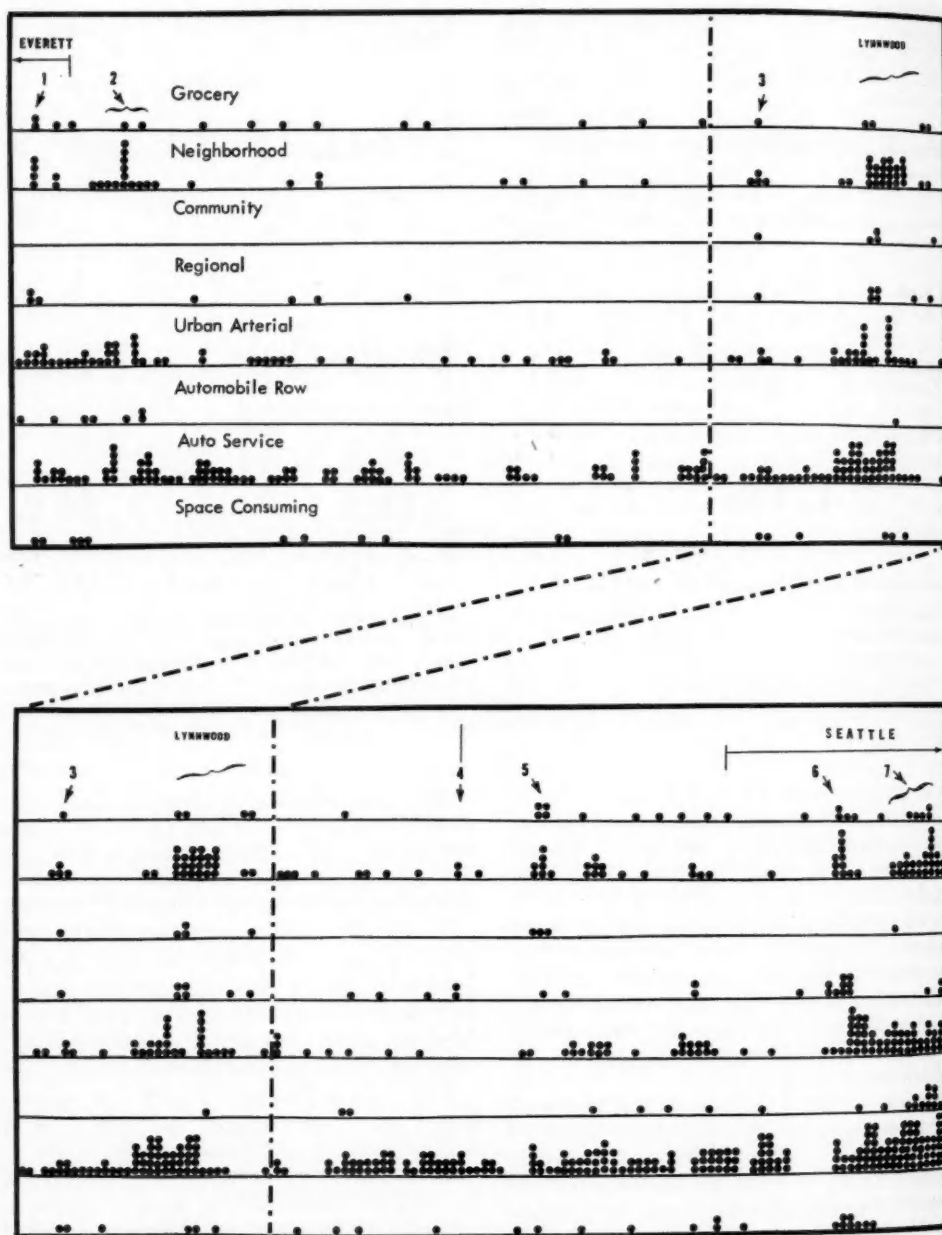


FIG. 6. Distribution of business types within groups in successive eighth-mile annules along U. S. Highway 99. One dot represents one business establishment, plotted by occurrence in the eighth-mile annule regardless of side. Note how the two parts of the figure overlap around Lynnwood. At top left, data are available within the city limits of Everett; at bottom right they extend into Seattle. Nucleations identified by number are as follows: 1, B and M; 2, Safeway; 3, Sno-King Drive-In; 4, Snohomish County-King County Line (also known as Sno-King); 5, Richland Highlands; 6, unnamed, North Seattle; 7, Green Lake. These data were collected in the field by Mr. Alexis Shakar.

secondary automobile row has developed midway along Division Street. In this are found smaller establishments than on Sprague Avenue, concerned with sales of foreign cars.

Use of Lorenz curves in Figure 5 (which uses data for Division Street) provides further information concerning concentration and dispersion of the groups of business types. Identical patterns of dispersion of urban arterial and highway-oriented facilities are revealed. On the other hand there is successively greater concentration of neighborhood and community facilities. The reader will be able to verify these statements using the block data in Figure 4. Further Lorenz curves are used to substantiate generalizations from the U. S. Highway 99 data (Fig. 7).

A classification problem which remains to be corrected is revealed by inspection of the regional shopping group in Figures 3 and 4. Drive-in banks are included in the bank category, and all professional offices (architects, etc.) in the professional office category. This classification is inadequate. New drive-in banks on Sprague Avenue and professional offices on both Sprague Avenue and Division Street are responsible for the apparently greater dispersion of regional than of community shopping facilities.

Inter-Urban Arterial Business

Data for a 25-mile stretch of business along U. S. Highway 99 between Seattle and Everett, Washington, are presented in Figure 6, the two halves of which may be matched by the overlap around the town of Lynnwood, as indicated. The significance of comparing horizontal and vertical trends hardly needs further emphasis beyond even the most cursory examination of these data. Nucleations are readily isolated (for example, centers such as Richland Highlands, numbered in Fig. 6; see also Fig. 2), and their hierarchical rank may be obtained directly from readings of the first four levels of the diagram. Automobile row establishments appear only in the Green Lake area within the city limits of Seattle and at the approaches to Everett. Highway-oriented facilities are spread relatively evenly along the highway. However, the gradual increase of these highway-oriented uses per eighth-mile annule within the city of Seattle is entirely to be expected, considering the amount of traffic which flows daily between

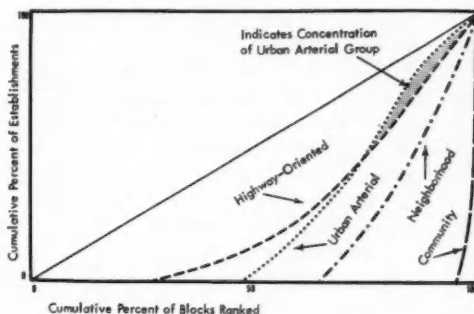


FIG. 7. Lorenz curves plotted for four groups of business types using U. S. Highway 99 data. Eighth-mile annules are ranked in ascending order of number of establishments along the abscissa. Note the contrast between highway-oriented and urban arterial types in this inter-city case.

the city, suburban areas, and dormitory towns north of the city limits.¹⁶

Figure 5 emphasizes similarity of the locational patterns of urban arterial and highway-oriented facilities along arterial highways *within* cities. Examination of Figure 6 fails to bear out this observation for business ribbons *between* cities. This point may be illustrated by using the Lorenz curves in Figure 7. Whereas community and neighborhood shopping facilities are highly concentrated, highway-oriented functions show considerable dispersion. Urban arterial functions are more concentrated than the highway-oriented, located in and near nucleations. Note in particular how the curve for highway-oriented facilities appears to the left of the curve for urban arterial business at lower left, and to the right in upper sections. This divergence suggests greater dispersion of highway-oriented functions, and a higher degree of concentration of urban arterial functions, than was noted in Figure 5. There is evidence to support the thesis that urban arterial functions seek out nucleations, and within nucleations they are most successful when oriented to major city streets.

CONCLUSIONS

The Spokane and associated studies provided enough substantive evidence to permit generalization concerning the spatial structure of retail and service business within cities. Using this body of generalization as a guide in

¹⁶ Garrison, Berry, *et al.*, *op. cit.*

the analysis of business ribbons, it has been possible to differentiate nucleations, special functional areas (such as automobile row), and stretches of urban arterial and highway-oriented business. Differences in the location habits of urban arterial business in inter- and intra-urban ribbons have also been noted.

Generalizations about the nature of ribbon business are therefore possible. It is evident that such generalizations are logical parts of the earlier statements concerning urban business structure. Knowing this, it has since proved possible to evaluate more objectively than might otherwise have been the case contemporary practices of planning and zoning for business.¹⁷ Likewise, having reduced the complexity of reality to a few meaningful and empirically valid dimensions, study and evaluation of the geographic and economic impact of highway improvements has been facilitated.¹⁸ It remains to comment about implications of the findings for central place theory, which has long been used as a basic theoretical tool in geography to explain the size, spacing, and functions of urban settlements.

It was noted in the study of U. S. Highway 99 that such towns as Lynnwood and Richland Highlands could be readily identified in terms of their nucleated business types. Central place theory has been verified in several situations which include towns such as Lynnwood. Indeed, one test of central place theory was undertaken in Snohomish County, Washington, and included Lynnwood within the sample of central places studied.¹⁹ The hierarchical rank of Lynnwood in the present study, derived from inspection of Figure 6, is the same as that obtained using other methods in the study of central places. Parallels between findings concerning the nucleated business types and studies of central places are in general so strong that it can only be concluded that central place theory is applicable to the analysis of the size, spacing, and functions of nucleated shopping centers located within cities as well as to functional characteristics, etc., of alternative urban settlements. [Arguments and premises inherent to

central place theory are sufficient to provide a logical and satisfactory explanatory scheme of the entire set of nucleated business centers.

But central place theory, at least in its present form, is not adequate to explain stretches of highway-oriented or urban arterial businesses. Neither is it adequate to account for specialized functional areas, such as automobile row. Some broader body of theory seems necessary to account for the spatial structure of all types of retail and service business. Important elements which this more general body of theory should include, in addition to present central place theory, are suggested to be:

(1) Recognition of a clear distinction between demands focussing upon nucleated centers and demands accruing as flows along arterials.²⁰

(2) Evaluation of the competing pulls for agglomeration of like uses into functional areas, perhaps with increasing specialization of establishments, and for the spacing of complementary uses in the shopping centers and business districts of the hierarchy.²¹

Clarification of these additional elements is obviously needed, and accumulation of further empirical evidence would be of great value. If this work were forthcoming, prospects

²⁰ A recent unpublished study by William Bunge entitled "The Location of Population, Demand, Purchasing Power, and Services on Highways" (University of Washington, Department of Geography, 1958) outlines the character of this latter set of demands as follows: needs of automobiles with distance travelled (fuel, etc.); periodic needs of people both as a function of time elapsed and time of day (food, rest, toilet); random needs with prevalence according to traffic volumes (repair, etc.). He argues that these demands, although occurring lineally instead of areally, as with the usual concept of trade areas, may be treated exactly as demands are treated using the threshold concept in central place theory. A locational pattern and a hierarchy necessarily follow, even though highway-oriented. This is the first treatment known to the author which puts analysis of highway-oriented business in a common framework with analysis of nucleated business types.

²¹ Otis Dudley Duncan recently presented an excellent analysis of specialization tendencies in the service trades over a range of city sizes: "Service Industries and the Urban Hierarchy," *Papers and Proceedings, Regional Science Association*, Vol. 5 (1959, forthcoming). See also "Comments Upon the Ecological Analysis of Regions" immediately following Duncan's article in the same volume, by Brian J. L. Berry.

¹⁷ Brian J. L. Berry, "A Critical Note Concerning Planning for Shopping Centers" (University of Chicago, 1958).

¹⁸ Garrison, Berry, *et al.*, *op. cit.*

¹⁹ Berry and Garrison, "The Functional Bases of the Central Place Hierarchy," *op. cit.*

would be ripe for development of a general theory of the spatial structure of tertiary activity.²²

²² As this paper was being edited, the University of California Press released a study of ribbon business on Ventura Boulevard in Los Angeles. See Gerard J. Foster and Howard J. Nelson, *Ventura Boulevard: A*

String-Type Shopping Street (University of California, Los Angeles, Real Estate Research Program, 1958). This study contains valuable information concerning the occurrences of business types along the highway, relationships of these business types to traffic volumes and population densities, the nature of trade areas, etc. Preliminary inspection of this information seems to indicate repetition of the patterns reported in this paper.

ZONAL INDICES AS RELATED TO THE WINTER CLIMATE IN EAST ASIA¹

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THE three basic zonal currents in the general circulation of the atmosphere are: polar easterlies, mid-latitude westerlies, and subtropical easterlies. Although a unified theory of the general circulation has yet to be formulated, it is well known that the strength of the zonal flow is closely related to the synoptic weather sequences, and hence to secular or long-period climatic changes. In 1939, Rossby introduced zonal index as a measure of the mean speed of sea level and mid-troposphere westerlies between 35° and 55°N, calculated by taking the mean pressure difference between these latitudes on equally spaced meridians.² This concept has gained prominence in meteorology and has been expanded to cover other branches of the circulation, e.g., polar easterlies and subtropical easterlies. To a large extent the indices govern the location and intensity of centers of action, the amplitude and wave length of a constant absolute vorticity trajectory, the meridional exchange of air masses, the anomalies of meteorological elements, and the like. In essence, the indices are a measure of properties and processes in the atmosphere on a large scale.

Rossby's idea was first studied in detail by a group of meteorologists at the Massachusetts Institute of Technology.³ They characterized the typical circulation patterns, and mapped the temperature anomalies in North America during periods of high and low westerly indices. The daily zonal index has subsequently been used for extended forecasting. More recently, Kopcewicz related cyclogenesis and cyclonic tracks in Europe to the zonal

index.⁴ Rex⁵ and Namias⁶ have tackled the problem of climatic changes in Scandinavia in the light of circulation intensities. These and kindred studies are mostly concerned with Europe and North America. However, the behavior of the zonal index in Asia, which is often the starting point for significant changes of index patterns in the northern hemisphere,⁷ remains to be investigated. It is the purpose of this study to fill part of this lacuna.

COMPUTING LOCAL ZONAL INDICES

The northern hemisphere zonal westerly index has been available for more than 40 years. The hemispheric index, however, is not significantly correlated with the index of the Asiatic section.⁸ Therefore, local indices are computed in this study in order to obtain a better correlation with the local meteorological elements. The selected area extends from 60° to 160°E with its center in east Asia. The Himalayan-Tibetan massif is included because of its profound influence on flow patterns. The selected distance of 100 degrees longitude is approximately the length of an average planetary long wave in middle latitudes.

The zonal indices can be computed on the basis either of pressure differences (giving resultant geostrophic wind) or of wind profile. Although the zonal wind-speed profile possesses the advantage of portraying the position of the jet stream, its data are rather meager. The pressure data, on the other hand, are readily available from the *Northern Hemisphere Historical Maps*.⁹ Daily values for

¹ The author wishes to thank Professor R. A. Bryson, University of Wisconsin, for his suggestions and comments.

² C. G. Rossby, "Relation Between Variations in the Intensity of the Zonal Circulation of the Atmosphere and the Displacements of the Semi-permanent Centers of Action," *Journal of Marine Research*, Vol. 2 (1939), pp. 38-55.

³ R. A. Allen, R. Fletcher, J. Holmboe, J. Namias, and H. C. Willett, "Report on an Experiment in Five-day Weather Forecasting," *Papers in Physical Oceanography and Meteorology*, M.I.T. and Woods Hole Oceanographic Institution, Vol. 8, No. 3 (1940), 94 pp.

⁴ T. Kopcewicz, "Indices of Circulation, Cyclogenesis and Cyclonic Tracks in Europe," *Idojaras*, Vol. 58 (1954), pp. 397-406.

⁵ D. F. Rex, "Blocking Action in the Middle Troposphere and Its Effects upon Regional Climate," *Tellus*, Vol. 2 (1950), pp. 196-211 and 275-301.

⁶ J. Namias, "Characteristics of Cold Winters and Warm Summers over Scandinavia Related to the General Circulation," *Journal of Meteorology*, Vol. 14 (1957), pp. 235-50.

⁷ H. C. Willett, *Descriptive Meteorology* (Academia Press, 1944), p. 147.

⁸ Allen *et al.*, *op. cit.*

⁹ Air Weather Service, *Daily Synoptic Series Northern Hemisphere Weather Maps*, 1934-37.

three winters, December–February, 1934–37, were analyzed. The pre-war data were used because, since 1937, the unsettled political situation in the Far East has entailed numerous interruptions in meteorological reports.

In addition to the zonal westerly index (35° – 55° N), the two commonly associated indices of polar easterlies (70° – 55° N) and subtropical easterlies (35° – 20° N) were also computed. For each latitude, the pressures at 5 degree intervals of longitude were averaged to obtain the mean.

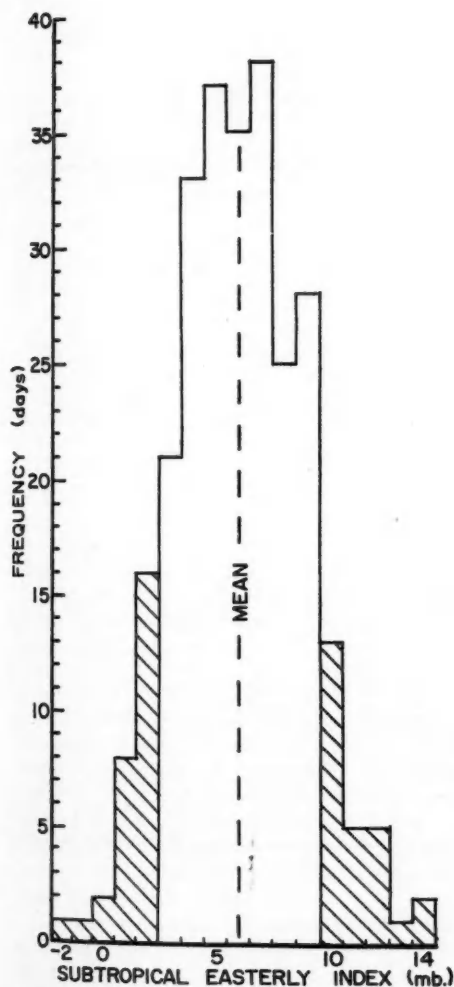


FIG. 1. Frequencies of subtropical easterly index.

FREQUENCIES OF INDICES

The frequencies of daily zonal indices for the 271 winter days are presented in Figures 1–3. The upper and lower one-tenths of the values, shaded in the histograms, are defined as high and low indices, respectively.

It is clearly seen that the subtropical easterly index fluctuates within narrow limits. Its extremes differ by only 16 millibars, as against 38 millibars for westerlies and 46 millibars for polar easterlies. Thus the primary zone of the latitudinal shift of mass of atmosphere is between the subtropical high pressure belt and the polar anticyclone. The small day to day changes of pressure (excluding tropical storms) render the zonal index a tool of relatively little usefulness in the tropics.

Both the westerly and polar easterly indices have a negative mean value in east Asia, indicative of a radical departure from the normal circulation patterns. This deviation is due to the strong influence of monsoons in perturbing the uniform zonal flow.

The mean of the westerly index is -2 millibars, corresponding approximately to a geostrophic east wind speed of 0.65 m/sec. By contrast, the normal sea level maximum zonal wind in winter for middle latitudes in the northern hemisphere is as a whole westerly with a speed of 2.25 m/sec.¹⁰ It should be noted, however, that the east wind is restricted to the lower atmosphere; west wind prevails in mid-troposphere in eastern Asia.

The frequency distribution of the westerly index is asymmetrical with the longer tail to the right. The skewness, or the third moment, of the curve has a positive value of 0.33 , indicating that high values are less frequent than low. This is in agreement with a previous analysis of the frequencies of the hemispherical westerly indices for mid-troposphere.¹¹

The mean of the polar westerly index in east Asia is -5 millibars, or approximately a geostrophic west wind of 1.24 m/sec. The extreme value of -30 millibars corresponds to an average west wind of 6.76 m/sec. These are prob-

¹⁰ H. C. Willett, "Final Report of the Weather Bureau–M.I.T. Extended Forecasting Project for the Fiscal Year July 1, 1948–June 30, 1949" (mimeographed, 1949).

¹¹ J. Namias and P. F. Clapp, "Observational Studies of General Circulation Patterns," in *Compendium of Meteorology*, American Meteorological Society, 1951, pp. 551–67.

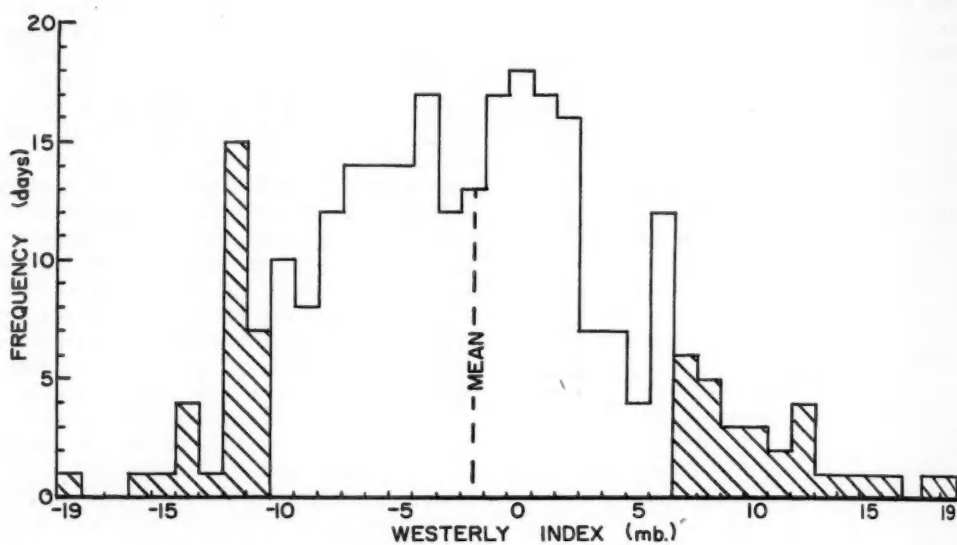


FIG. 2. Frequencies of westerly index.

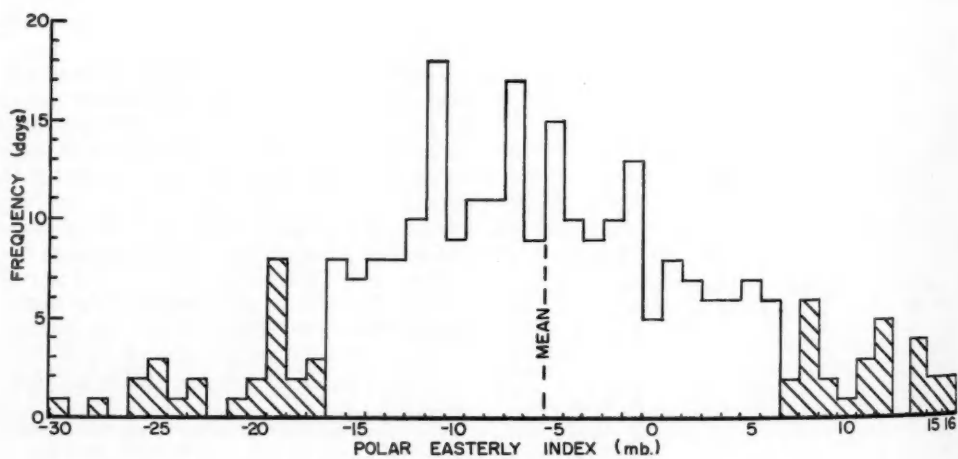


FIG. 3. Frequencies of polar easterly index.

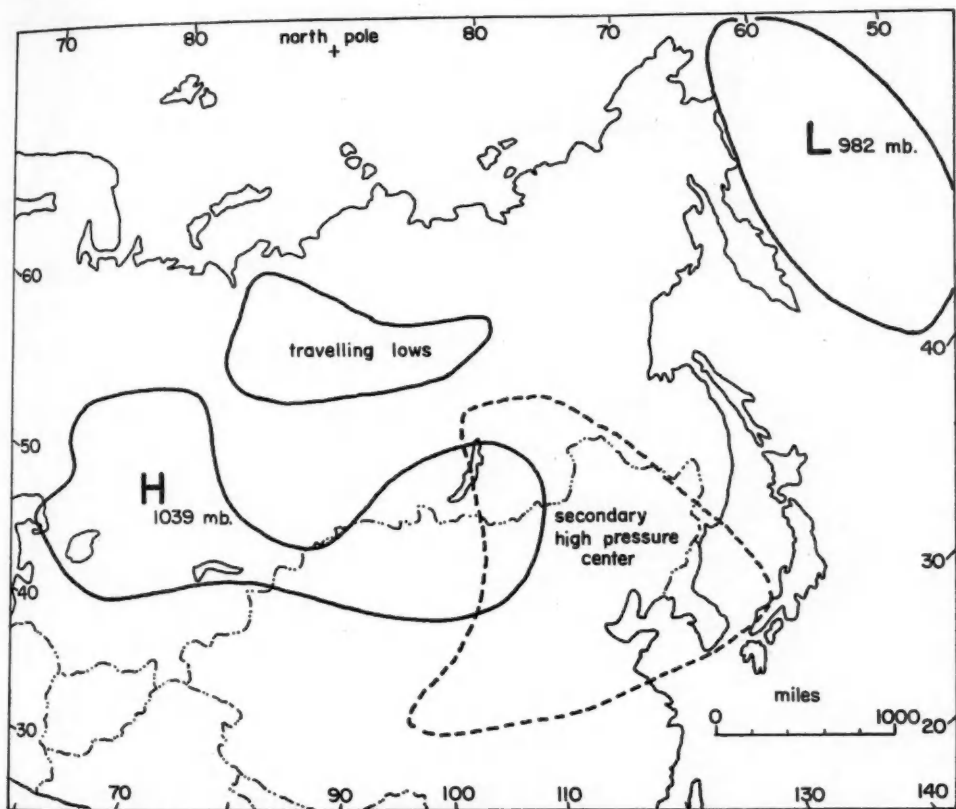


FIG. 4. Locations of centers of action during periods of high westerly index.

ably the greatest anomalies from the normal zonal index in the world. The frequency curve of the polar easterlies has a negligibly small skewness of -0.1 .

ZONAL INDICES AND CENTERS OF ACTION

The intensity and location of centers of action are closely related to the zonal indices. During a period of maximum subtropical easterlies the Asiatic high is located over Dzungaria and the Gobi Desert. When the subtropical easterlies are weak, the Asiatic high moves to Siberia, or it may occasionally reach the Taimyr Peninsula.

The fluctuations of the westerlies and polar easterlies reflect the combined effect of the Asiatic high and the Aleutian low. In Figures 4-7 are delineated the areas within which cen-

ters of action were located during the specified periods. When the westerlies are strong, the high pressure is centered over the Khirghiz Steppe or Outer Mongolia, often with a secondary center over Manchuria (Fig. 4). Travelling cyclones, coming from the Atlantic and Europe, frequently make their appearance in the Lower Yenesei Taiga. The Aleutian low is displaced slightly north of its normal position.

The Asiatic anticyclone is intensified by 11 millibars when the westerly index changes from high to low (Fig. 5). On December 9, 1935, a typical low index day, the pressure of the high exceeded 1070 millibars! Early work by Allen *et al.* treated westward displacement of the Asiatic high as one of the characteristics associated with the low hemispheric west-

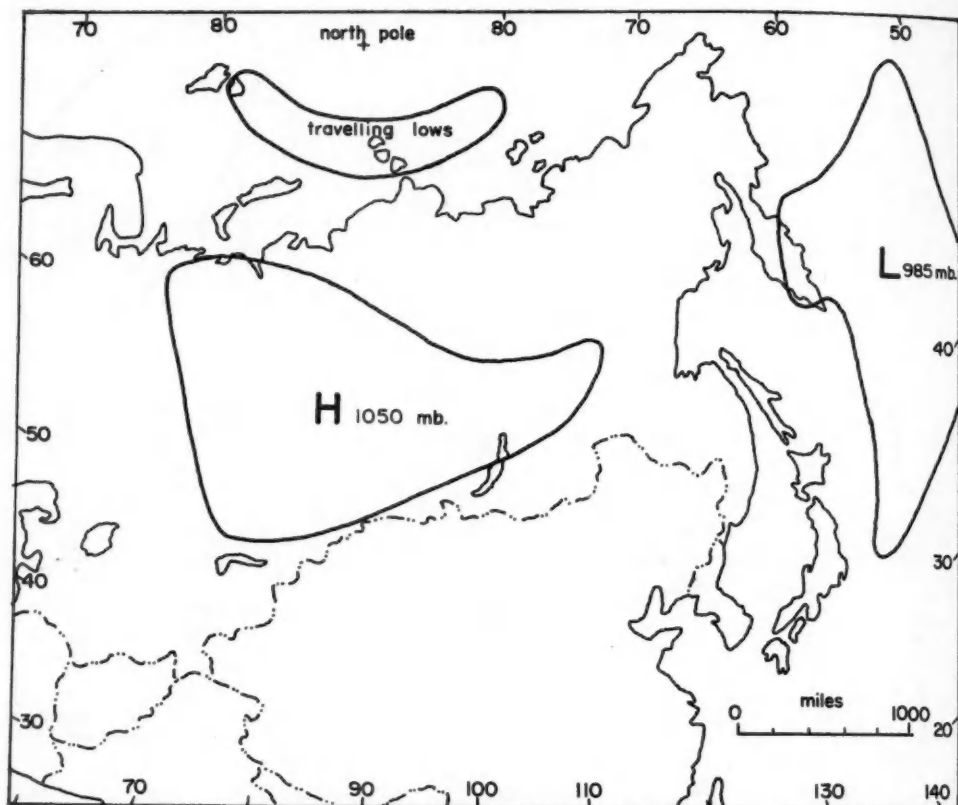


FIG. 5. Locations of centers of action during periods of low westerly index.

erly index.¹² The present study, however, reveals only a northward movement of the anticyclone. The prevailing cyclonic path is likewise pushed northward off the Arctic coast during periods of low westerly index. The Aleutian low moves southward and cyclonic disturbances frequently develop over and in the neighborhood of Japan.

During periods of high and low polar easterly indices the strengths of the centers of action are not greatly changed, but their locations are different. A northerly Asiatic high and a southerly Aleutian low are features accompanying low polar easterly index. The movement of the Aleutian low is oriented SE-NW during low index; for high index periods, it is east-west.

¹² Allen *et al.*, *op. cit.*

A comparison of Figures 4-7 indicates that the typical pressure patterns with high westerly index bear some resemblance to those of low polar easterlies; but it is by no means striking. The correlation coefficient between the two indices has been found to be 0.14, in spite of the fact that they possess 55°N in common.

TEMPERATURE AND PRECIPITATION ANOMALIES

In low latitudes, surface isobars bear no close relation to the distribution of temperature and rainfall. Ramage has confirmed this in a study of the summer weather in south China and its neighborhood.¹³ In winter the

¹³ C. S. Ramage, "Analysis and Forecasting of Summer Weather over and in the Neighborhood of South China," *Journal of Meteorology*, Vol. 8 (1951), pp. 289-99.

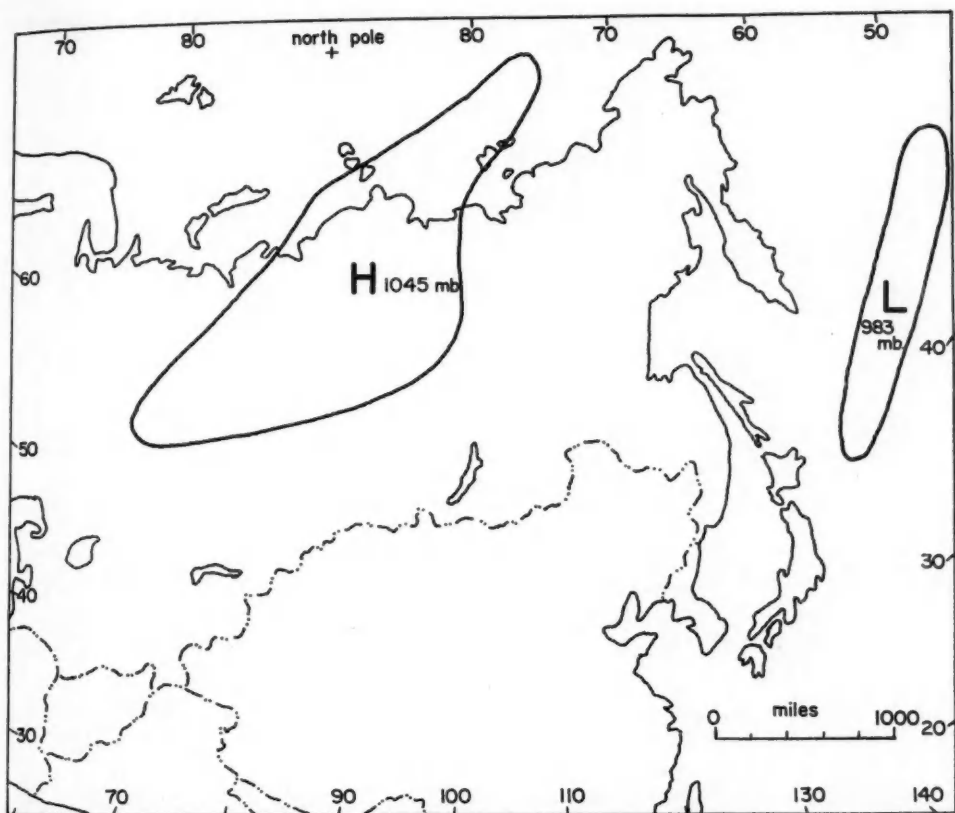


FIG. 6. Locations of centers of action during periods of high easterly index.

situation is similar. The subtropical easterly index has practically no climatological significance.

The westerly and polar easterly indices are, on the other hand, useful forecasting tools. Figures 8 and 9 show the average temperature departures from the monthly mean during periods of low westerly and polar easterly indices, respectively, using the data of 70 stations. Temperature departures for periods of high index are normally the reverse of those for low index except where the frequency curves of daily temperature are markedly skewed. Maps of precipitation anomalies have not been constructed because of the variability of precipitation and the insufficiency of data.

During a period of weak westerlies, the

Asiatic anticyclone is well-developed and the continent is more prone to monsoon circulation. Radiational cooling is favored and cold waves of continental polar air masses propagate down to the coast of south China. Therefore, with the exception of northern Siberia, the continent of east Asia has a lower temperature than normal. The greatest departure, 12°F , is found at Kirensk near the center of the anticyclone. The southward bulge of the -4°F isanomaly in the Lake Basin fits well with the so-called "cold pocket," or a tongue of the polar continental air.¹⁴ The zero is-

¹⁴ J. H. Chang, "The Climate of China According to the New Thornthwaite Classification," *Annals, Association of American Geographers*, Vol. 45 (1955), pp. 393-403.

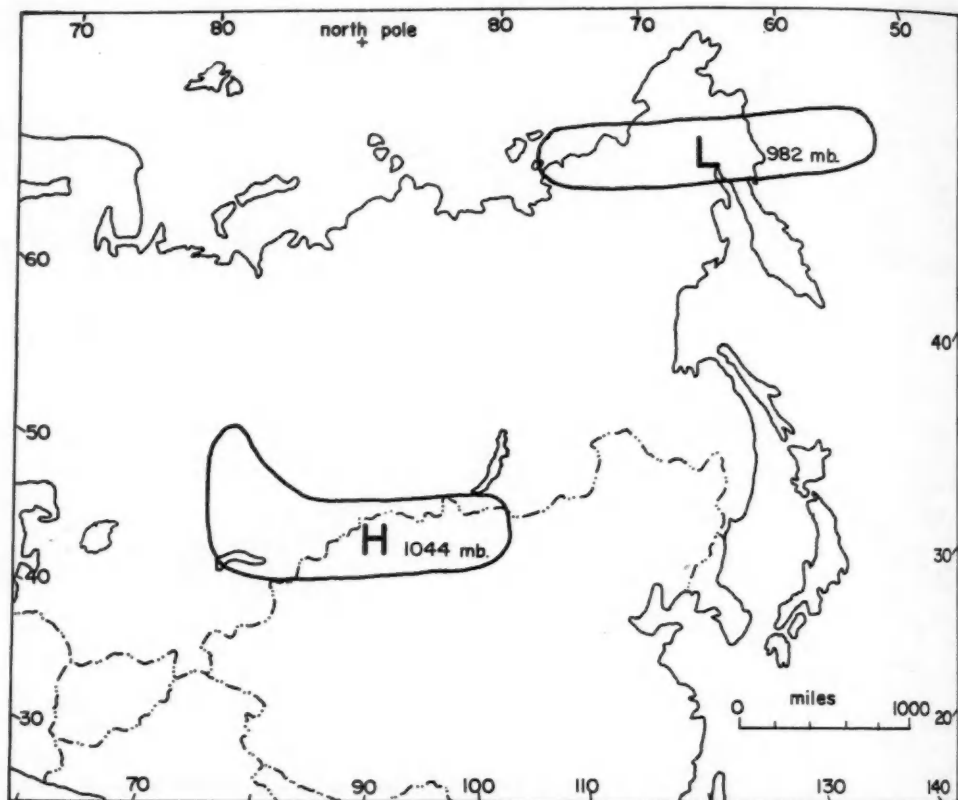


FIG. 7. Locations of centers of action during periods of low polar easterly index.

nomaly south of Japan coincides with the mean position of the polar front.¹⁵

During weak westerlies, the precipitation in Siberia is below normal. To the south of Siberia meridional exchange of air masses is, however, in full swing. The polar continental air becomes moisture-laden when it reaches Japan and the east coast of China. Matsukura reported that heavy winter rain in Japan occurs mostly with minimum index.¹⁶ In central and south China, the same situation has been noted. There the mechanism of precipitation

is, however, different. It may be suggested that when the Asiatic high is over Siberia with low index, the jet stream south of the Himalayas becomes strengthened which is conducive to cyclogenesis and abundant rainfall in southern and central China.¹⁷

In Siberia the temperature and precipitation variations are better correlated with the polar easterlies than with westerlies. During weak easterlies, the temperature at Oleminsk is 16°F below normal. On the contrary, the Kamchatka Peninsula is unusually warm under the direct influence of the Aleutian low. Winter precipitation is decidedly more fre-

¹⁵ J. H. Chang, "Air Mass Maps of China Proper and Manchuria," *Geography*, Vol. 42 (1957), pp. 142-48.

¹⁶ H. Matsukura, "An Analysis of the Heavy Rains by Zonal Index," *Journal of Meteorological Research*, Vol. 2 (1950), pp. 54-58.

¹⁷ T. C. Yeh, "The Circulation of the High Troposphere over China in the Winter of 1945-46," *Tellus*, Vol. 2 (1950), pp. 173-83.

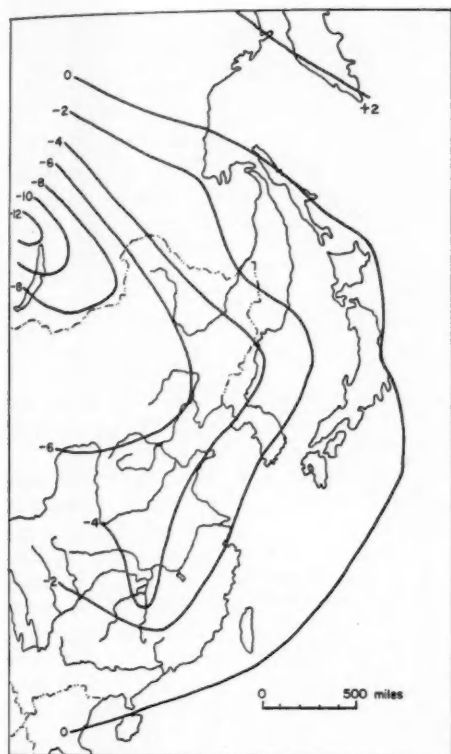


FIG. 8. Temperature departure from normal in °F during periods of low zonal westerly index.

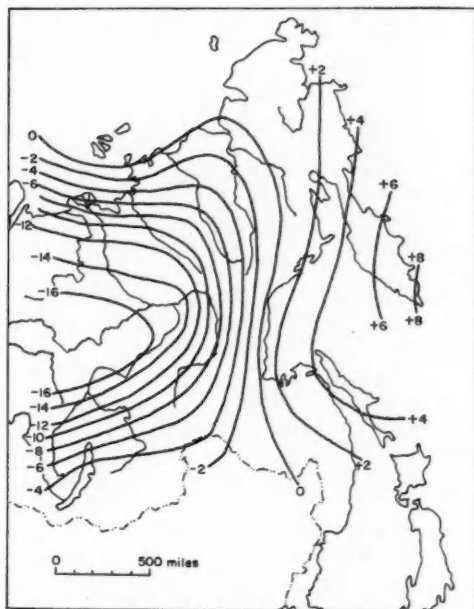


FIG. 9. Temperature departure from normal in °F during periods of low polar easterly index.

present findings, previous unrelated and often seemingly conflicting investigations by Chu,¹⁸ Wittfogel,¹⁹ Huntington,²⁰ and others, could be pieced together to portray an integrated picture.

¹⁸ C. C. Chu, "Climatic Pulsations During Historic Time in China," *Geographical Review*, Vol. 16 (1926), p. 274.

¹⁹ K. A. Wittfogel, "Meteorological Records from the Devination Inscription of Shang," *Geographical Review*, Vol. 30 (1940), pp. 110-33.

²⁰ E. Huntington, *The Pulse of Asia* (Boston and New York, 1907).

quent during low easterly index than during high.

The above discussion should be of great value in studying climatic changes. For instance, knowing the past climate in Mongolia, it is possible to infer the winter conditions elsewhere in east Asia. In the light of the

CHARLES C. ADAMS, 1873-1955

HUGH M. RAUP

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CHARLES C. ADAMS was born in Clinton, Illinois, on July 23, 1873, and died at Albany, New York, May 22, 1955. He obtained a bachelor's degree at Illinois Wesleyan College in 1895, and the degree of Master of Science at Harvard in 1899. He then studied at the University of Chicago from 1900 to 1903, where he took his doctorate. At Chicago he was at the center in which American ecology and ecological biogeography were being developed under the leadership of Henry Chandler Cowles and his students. There also he came under the influence of Rollin D. Salisbury, an extraordinarily inspiring teacher in the earth sciences. For a period of years following his graduate work he held varied research and curatorial positions in universities and other institutions in the Middle West, and in 1914 he took a position as Forest Zoologist at the New York State College of Forestry at Syracuse.

Adams remained in the New York State service until his retirement in 1943. He directed the Roosevelt Wildlife Experiment Station from 1919 to 1926, and in the latter year became Director of the New York State Museum at Albany. Soon after leaving Chicago he had become interested in museum work, and this was a primary interest throughout the remainder of his life. He saw in the field of ecology what he considered to be an outstanding medium for teaching and museum demonstration in the natural sciences. Many of his later publications were in support of this idea.

A bibliography of his publications totals 154 titles. Their subject matter is extremely varied, from research papers on fresh water mollusks to such things as the "Application of Biologic Research Methods to Urban Areal Problems." He was active in several scientific societies, and was one of the early members of the Association of American Geographers. He served as second vice-president of the Association in 1913, and as vice-president in 1927. In 1916 he was one of the founders of the Ecological Society of America, and was its president in 1923. He had a large correspondence, and accumulated an extensive personal library of

books and reprints. All of this material has been given by his daughter to Western Michigan College at Kalamazoo, where it forms the nucleus of what has become known as the Charles C. Adams Center for Ecological Studies, located in the Department of Biology at that school. There were in his files at the time of his death sizeable residues of reprints of his own published papers, even of the earlier ones. The recently established Center, through its director, Dr. Daniel F. Jackson, has made these reprints freely available to institutions and individuals.

It is probable that Dr. Adams was most widely known for his publications in the field of animal ecology, for his attempts to apply ecological research methods to the problems of human communities, and for his continual emphasis upon ecology as a teaching mechanism. The conceptual difficulties involved in the construction of rationales in all these areas were, and are, formidable; and he met them with integrity and humor. Appreciations of his efforts with them, published since his death, are evidence of the high esteem accorded him by ecologists.¹ On the other hand, some of his earlier research in biogeography may, in larger perspective, prove to be of equal significance.

One of his major research papers, published as a Memoir in the National Academy of Sciences in 1915, is on the "Variations and Ecological Distribution of the Snails of the Genus *Io*." This genus of snails inhabits only the upper reaches of the Tennessee River in southwestern Virginia, eastern Tennessee, and northern Alabama. Adams did a great deal of field work on them himself, and had access to a large quantity of earlier collections. He made careful studies of variations within species, and related these variations to distribution patterns. From his studies he was able to define certain clines of variation within and among the species occurring at various levels in the valleys of the rivers inhabited by the

¹ Paul B. Sears, "Charles C. Adams, Ecologist," *Science*, Vol. 123 (1956), p. 974; Ralph S. Palmer, "Dr. Charles C. Adams," *Bulletin, Ecological Society of America*, Vol. 37 (1956), pp. 103-5.

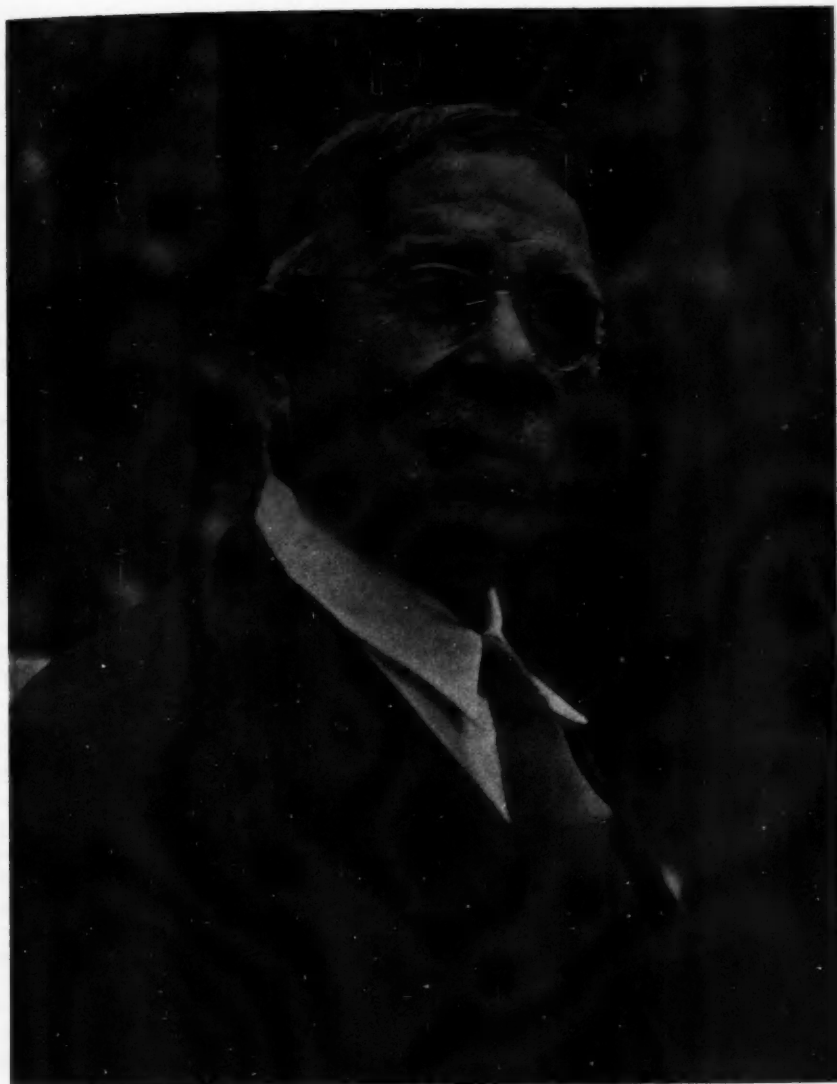


Photo by Dorothea Kehaya

CHARLES C. ADAMS

snails. He suspected that much of the variation was due to interbreeding of closely related forms, and pointed out the problems attendant upon experimental proof of his supposition. This was pioneer work, not merely in a taxonomic study of the species, but in his statement of the problem of clinal variation as applied to the mollusks, and in his understanding of its significance in speciation and geographic distribution.

Another area of research in which he made major contributions is set forth in three papers on the origin and migrations of the North American biota. The first of these was entitled "Southeastern United States as a Center of Geographical Distribution of Fauna and Flora";² the second was on the "Post-glacial Origin and Migrations of the Life of Northeastern United States";³ and the third was on the "Post-glacial Dispersal of the North American Biota."⁴ These papers, as aptly stated by Cain, are "outstanding in their conception of process in biogeography."⁵ Adams' starting point was in the areal geography of species and major form categories of the vegetation. In this he was firmly in the tradition of Engler and Asa Gray, and sharply at variance with a strong trend in American plant ecology and geography that was appearing at the time. This was the tendency to discard the species as a unit of study in favor of the plant community, considering the latter in a quasi-organic sense. Zoological ecologists have never divorced themselves so completely from their basic units of study, and Adams' later publications on the genus *Io* indicate that he maintained intact the tradition adhered to in his papers of 1902 and 1905. What he might have done with further research in plant geography we can only guess, but it is of interest to note some ideas found in these early papers that indicate unusual prescience.

Adams found himself with the need to deal with one of the most difficult problems in biogeography: that of centers of origin for species and biotas. In the first of the three papers mentioned he set up ten criteria for judgment as to the center of origin of a given flora or

fauna. Cain has published a searching analysis of these criteria based upon a large volume of more recent research in which findings in the fields of genetics and cytology have been of major significance.⁶ Although Adams' criteria must be modified at many points in light of this more recent research, they are still exceedingly useful as a frame of reference, and it is remarkable that he stated the basic problem so clearly and so provocatively with the limited materials he had at hand. Even though we can now greatly elaborate and illuminate his statement, we are still far from solving the problem of center of origin.

In the third of the above-mentioned papers on biogeography (1905), Adams attempted a general hypothesis to account for the repopulation of the glaciated parts of North America after the disappearance of the last ice. He followed Darwin and Hooker in being more impressed with the idea of great "waves" of migration of fauna and flora before and after glaciation than we now are; and his concepts of the ice age itself, with its post-glacial climates, were uncomplicated by problems that students now have to face. Further, there were in his time vast blocks of territory in boreal America about which virtually nothing was known. In spite of these things we can find in his analysis some ideas that are surprisingly modern.

He thought, for instance, that the arctic and northern alpine biota probably lived throughout the Pleistocene on northern lands that were not completely covered by ice, and that it was essentially "nomadic" (his term). This is almost precisely the description given thirty years later by Hultén for his "Arctic-montane" group of boreal plants.⁷ It is now believed that because of their "nomadic" character and their inherent tolerance of arctic conditions these plants were able to maintain large populations and a high degree of plasticity throughout the Pleistocene. Thus they have survived with wide arctic ranges, many of them circum-polar.

Adams sensed that the boreal spruce-fir forest, in spite of its apparent uniformity of structure and its continuity from Newfoundland to Alaska, could not be entirely homogeneous,

² *Biological Bulletin*, Vol. 3 (1902), pp. 115-31.

³ *Journal of Geography*, Vol. 1, Nos. 8 and 9 (September and October, 1902).

⁴ *Biological Bulletin*, Vol. 9 (1905), pp. 53-71.

⁵ Stanley A. Cain, *Foundations of Plant Geography* (Harper and Brothers, 1944), p. 185.

⁶ *Ibid.*, pp. 185-211.

⁷ Eric Hultén, *Outline of the History of Arctic and Boreal Biota during the Quaternary Period* (Stockholm, 1937), p. 87.

and could not all have had the same origin. He derived most of it from suspected relic areas in the Appalachian region and the Rocky Mountains; but he also made the acute observation that "Certain elements have apparently pushed far northwest to the Rocky Mountains, to the Mackenzie basin, and even overflowed into the Yukon valley—the reverse route, in all probability, was followed by certain Asiatic forms into America." He had already noted an Asiatic element in the arctic biota of northern Alaska, and brought up the matter of eastern Asiatic types again later in connection with his discussion of the western mountain center of dispersal.

In all of this he was quite close to more recent concepts. He saw the confusion that exists between eastern and western elements of the spruce-fir forest, and sensed what it meant. Some later students would restrict the populations of the eastern relics of this forest more than he did, and give priority to the northern Rocky Mountain populations for first reoccupying much of the land now in Alberta and Mackenzie. But this was largely a matter of timing and distance, and the same region has now become a part of the great area of overlap and confusion between eastern and western elements that Adams saw. He was correct, however, in believing that many species range throughout the spruce-fir forest, and could have come into it from any of the available refugia, including eastern Asia.

Here, as with the arctic and Rocky Mountain biotas, he was suggesting what Hultén later called "Beringia radiants,"⁸ or species that came into America from an American-Asiatic area centering on the Bering Straits region. His information would not at that time allow him to separate his "Western Center of Dispersal" into northern Pacific slope and Rocky Mountain sections. Had he been able to do so, he would have suggested the "West American coast radiants" and the "Continental West American radiants" of Hultén,⁹ the behavior of which is blended among the plants from his Western Center.

The last half century is not long in terms of historical perspective, but it spans an immense development of geographic knowledge. The continued validity of so large a proportion of Charles C. Adams' geographic interpretations made early in this period entitles him to recognition as a creative student of American biogeography. He accomplished these things first by proficiency with the traditional tools of his field—the identity and areal distribution of plants and animals, and then by clear reasoning from simple comparison of the geographic patterns that were available to him. His portrayal of process was achieved with an admirable economy of hypothesis, which all of us would do well to emulate.

⁸ *Ibid.*, pp. 38-60.

⁹ *Ibid.*, pp. 65-80.

ABSTRACTS OF PAPERS PRESENTED AT THE 55TH ANNUAL MEETING
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FRANK O. AHNERT—*The Influence of Pleistocene Climates upon the Morphology of Cuesta Scarps on the Colorado Plateau*

In contrast to our knowledge about Pleistocene glaciation, pluvial lakes, and valley fills in the Southwest, little information is available on the effect of Pleistocene climates upon landforms below the zone of former glaciation, above the valley floors, and away from the areas of pluvial inundation. This paper tries to help fill this gap with an analysis of sandstone scarp faces in Monument Valley and northwestern New Mexico.

On these scarps there is a curious form association of vertical cliffs and bare bedrock slopes with a wide range of slope angles. Both occur on lithologically, structurally, and stratigraphically the same material. Either they lie side by side, or the bedrock slope lies above the cliff. In the latter case, the boundary between the two forms is either a sharp, easily traced edge or a rounded transition zone leading gradually from the gentler slopes above into the vertical cliff face below. Where this boundary is sharp, the cliff displays signs of freshness, indicating active cliff retreat after the slope above had been formed; where the boundary is indistinct, however, the gentler form apparently has advanced into the cliff below after the latter's retreat had ceased. These observations suggest that: (1) cliffs and gentler bedrock slopes were not formed simultaneously, but are results of different processes occurring at different times; and (2) conditions favoring cliff retreat and conditions favoring development of gentler slopes have alternated several times.

An attempt is made to correlate the development of these forms with the climatic fluctuations during the Pleistocene.

JOHN P. AUGELLI—*Racial and Cultural Complexity of West Indian Population: The Case of Trinidad*

The West Indies have been a meeting ground for people of diverse races and cultures during much of post-Columbian history, and as a result racial and cultural diversity has become a distinctive feature of the region's

population. This diversity is not everywhere the same, however. It varies with history, economic circumstances, the colonial policies of European powers, and other factors.

Perhaps no island in the West Indies illustrates the impact of race and culture on the structure of population more effectively than Trinidad. Except for the original Carib inhabitants, who were driven off or absorbed, each wave of arrivals to the island has managed to retain a hard core of distinctiveness, and as a result the composition of Trinidad's population is the most heterogeneous in the West Indies. Out of a current population of almost 800,000 approximately 400,000 are Negroes, 250,000 are East Indians, and the remainder is made up of French, Spanish, English, Portuguese, Syrian, Venezuelan, American, and other elements. The purpose of this paper is twofold: (1) to analyze the broad impact of the diversified composition upon the people-and-land milieu of Trinidad; and (2) to compare and contrast Trinidad with other West Indian islands in the light of racial and cultural diversity.

While not without overlap, some correlation exists in Trinidad between racial and ethnic differences and the patterns of religion, language, social classes, occupational preferences, political parties, diet, fertility rates, and other social expressions. The correlation extends in lesser degree to population distribution and settlements, land tenure and land use, and the relationship of Trinidad to the total West Indian complex.

ALBERT G. BALLERT—*On the Eve of the Seaway Era: Great Lakes Overseas Trade and Traffic*

The Seaway era is now upon us, providing mid-America with a facility for the full-scale use of ocean shipping for direct service with major trade areas of the world. Widespread future interest will be focused on the extent of the developing trade, weighed in the light of forecasts of prospective growth.

It is helpful and appropriate at this time to examine the current status of the Great Lakes overseas trade with respect to its nature and

extent. Present commerce serves as a base point for comparing the future flow of goods and ships and also as an indicator of the products likely to be prominent in the Seaway era. The material presented in this paper is directed toward meeting these needs. The data evaluated include the weight and dollar value of major commodities in the Great Lakes overseas trade and their foreign areas of origin and destination. A tabulation of some 180 overseas vessels making more than 500 trips into the Great Lakes during the 1958 navigation season provides the basis for a more detailed analysis of this traffic than has heretofore been possible.

THOMAS FRANK BARTON—*The Largest Railway Net in Continental Southeast Asia*

Bangkok is not only the hub of the largest railway net in continental Southeast Asia, but it is the hub of the only railway net that serves more than one country. Two-thirds of the net's mileage is in Thailand, but tracks extending in all directions from Bangkok carry goods and people on their way to the adjacent countries of Malaya, Cambodia, and Laos, as well as to the free ports of Penang and Singapore.

During the last two decades significant changes have been made in the extent, pattern, and function of this railway system. The net reached its greatest extent and theoretically served the largest area during the Second World War when the Japanese connected the rail systems of Thailand and Burma. Although the Japanese built two rail lines across the Tenasserim Range connecting Thailand and Burma, both of these lines have fallen into disrepair. During the Second World War, the Japanese altered the prewar railway pattern by ripping up the lines, primarily in Malaya. The rails were used elsewhere or for scrap iron.

Thailand is the only country of the group where railway mileage has increased since the war. In 1956, it added 35 miles to one of its Northeast lines in order to serve Nong Khai, on the Mekong River, and Laos. Now goods destined for Vientiane can be unloaded from ships in Bangkok, shipped in-transient by rail to Nong Khai, ferried across the river, and taken by truck to the capital.

Although the net enables goods to move among four countries, goods must be unloaded

at the border and reloaded on carriers operated by nationals of each country.

BRIAN J. L. BERRY—*Statistical Tests of Value in Grouping Geographic Phenomena*

One fundamental set of geographic problems involves grouping, classifying, or regionalizing. The common feature of this set of problems is the summarizing of large numbers of individual observations into smaller numbers of groups, classes, or regions, each of which contains members homogeneous with respect to a single criterion or several criteria. Certain aspects of the summarization process have been discussed by the author elsewhere (*Annals, Association of American Geographers*, Vol. 48, 1958). But for the summaries to have any merit it is necessary to know that the initial observations have inherent grouping tendencies. This paper describes statistical tests which provide such information; the tests themselves have geographic bases.

Data may be in the form of map, graph, or table, provided some measure of similarity of individual observations is present or may be derived. Given the measures of similarity, all reflexive groups of nearest neighbors are obtained in sequence: pairs, triples, etc. The observed sequence of occurrence of reflexive groups is compared with a theoretically random sequence, and it is then possible to decide whether the observed sequence is random (not significantly different from the theoretical sequence at an acceptable level of probability), more even than random, or more grouped than random. Only in the latter case is summary in the appropriate form (group, class, or region) justifiable.

The discussion is arranged at every stage around graphic materials illustrative of problems in economic geography. Some examples are: the spatial distribution of settlements, grouping habits of retail businesses, and measures of association in industrial geography. Uses in other areas of geographic research are suggested.

LLOYD D. BLACK—*Industrial Development for Rural Areas?*

Industrial development is one of the key objectives in President Eisenhower's Rural Development Program. Nevertheless, in his memorandum of September 6, 1958, announc-

ing the veto of S.3683 (the Area Redevelopment Act) he stated: "There is a serious question as to whether Federal loans for the construction of industrial buildings in rural areas would be a proper or effective approach. . . ."

This policy contradiction suggests the need to examine the pros and cons of industrial development in rural areas. In summarizing the results of such analysis the author is discussing one of the several opportunities for geographic research mentioned in a paper read at the Santa Monica meeting ("Economic Development by Legislation: Geographic Aspects of U. S. Unemployment and Underemployment").

Although rural underemployment has existed for many decades, the problem has been accentuated recently by the impact of technological and economic developments in agriculture which have made many farm units obsolescent or uneconomic. The 102 pilot counties in the Rural Development Program are analyzed to provide background characteristics of rural areas. Special Univac compilations from the 1954 *Census of Manufactures*, revealing the distribution of manufacturing by metropolitan and nonmetropolitan area, city and employment size, are analyzed to help determine those of the 450 census industries best suited to smaller towns and rural areas.

Industrial disadvantages of rural areas, such as lack of skilled labor, utilities, transportation, and cultural institutions, are evaluated, together with advantages of rural areas, such as higher labor productivity, lower taxes, lower occupancy costs, and rural living.

In view of engineering improvements that permit smaller-size plants, it is possible for an increasing number of manufacturing industries, in addition to those that are agriculturally oriented, to operate at a profit in small communities and rural areas.

JAMES M. BLAUT—*Cultural Determinants of Soil Erosion: A Case Study from Jamaica*

Accelerated soil erosion can be viewed as the end result of a chain of cultural-geographic processes leading from resource-using motivation (with its valuative, technological, and apperceptual determinants), through resource-using behavior, to the ecological effects of this behavior. The explanation and control

of erosion require analysis of these processes. The present paper describes an experimental study that sought to discover the processes leading to erosion and inhibiting the acceptance of conservation measures in a selected area, a severely eroded portion of the Blue Mountains of Jamaica. Four investigators took part: a conservationist, two anthropologists, and the writer as director.

Weathered parent material rather than soil is cultivated and slopes average 30° on the farms sampled for study. Population pressure has forced a shortening of the grass-fallow period, with the result that complete soil regeneration cannot occur in the absence of conservation measures. But these are generally rejected by farmers. For example, although a shift from the traditional, and highly erosive, ground crops to tree crops is recommended by extension agents, most farmers still favor the former. The explanation involves several complex factors, among them the following: (1) because of insecure tenure, trees are not planted on rented land, which predominates; (2) most farmers cannot afford the temporary income loss before trees mature; (3) marketing of ground crops—foods—is socially important for women; (4) food crops are viewed as a form of "subsistence insurance" against adverse economic conditions; (5) apperception of erosion and its consequences is invariably either imperfect or absent entirely.

CHARLES W. BOAS—*Locational Patterns of American Automobile Assembly Plants, 1895-1958*

In a geographical sense, the manufacture of passenger automobiles is most often associated with Michigan and the city of Detroit. Too little recognition has been given to the total number of passenger automobile assembly plants and their locations. Examination of the operations of 2683 assembly plants during the period 1895-1958 reveals the basic locational patterns of this segment of the automotive industry.

These firms operated in 688 locations in 46 states. Based on the total number of plants entering production during the 63-year span, New York, Michigan, and Ohio rank as the leading states, each with more than 300 operations. Illinois, Massachusetts, Pennsylvania, Indiana, and New Jersey each had more than

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100 operations. By the same criteria, the most important cities have been Detroit, Chicago, New York, and Cleveland, each with more than 100 operations. Forty-two other cities had more than 10 operations each.

By plotting the operating assembly plants for selected years within the period 1895-1958 a shift in assembly operations may be traced. From 1895 to 1905 the New England and Middle Atlantic states equaled or exceeded the Midwestern states in total number of operating plants. The greatest years of activity in Ohio, Illinois, and Indiana were 1909 and 1910. Michigan reached its peak operational activity in 1914, the record year of operation for the industry. A revival of operations in 1921-22 on a nationwide basis did little to alter the concentration of assembly activity in Michigan. After 1928 Michigan was the center of automobile assembly, in spite of a growing number of branch plant operations. The study suggests that the changing locational patterns of the industry had a profound effect on many more people and localities than has previously been supposed.

S. EARL BROWN—*Scranton's Unfulfilled Industrial Integrity*

Thirty years have passed since Zierer's study of Scranton's industrial integrity concluded that the city's future was "reasonably secure." This paper examines the present manufacturing in Scranton to determine its coincidence with the industrial development suggested by the earlier study.

The increase of industrial employment of approximately 60 percent since 1930 seemingly substantiates the industrial integrity, but only in metal fabrication has growth developed as predicted, and that slowly. Two major employers of 1930, predicted to continue, have both declined. The textile industry succumbed to the lure of the South, and the railroad shop employment decreased with the collapse of anthracite mining.

Sharp increases have occurred in the chemical and leather goods industries, but these play a small role in the total industrial picture. The apparel industry also exhibited rapid growth and now employs the greatest number of people. Hence Scranton is still plagued with predominantly female-employing units

which cannot contribute to a stable industrial community.

The problems associated with the transition from a mining to a manufacturing economy continue. An active Industrial Foundation advertises the basis of industrial integrity noted in 1930, abundant labor and sizable markets with which effective transport connections exist. Only when sufficient male-employing industry develops to retard emigration can it be said that the industrial integrity is fulfilled.

CLYDE E. BROWNING—*The Occupational Structure and Functional Role of the Chicago Central Business District*

One of the most critical problems facing our cities is the future of the central business district. Unfortunately there is considerable uncertainty regarding the current health of the CBD and its future prospects. Much of this uncertainty is rooted in inadequate information concerning the functions of the CBD. Too often its fate is thought of only in terms of retailing.

Recently, however, data obtained by the Chicago Area Transportation Study made available—in the form of "first work trips"—estimates of the importance of various CBD functions through an analysis of the occupational structure of the Chicago CBD. First work trips were coded to 10 major and 88 subsidiary categories of land use which are comparable to the Standard Industrial Classification. The data revealed not only what share a given category had of total CBD employment but what proportion of the total employment in that category was localized within the CBD. Manufacturing, for example, accounted for 11 percent of all CBD first work trips and 4 percent of all manufacturing first work trips terminated within the CBD.

A preliminary analysis of the data indicates that the service category (which includes office functions) had the greatest share of CBD employment (46.2%), followed by retailing (15.5%), manufacturing (11.3%), transportation (9.7%), and public buildings (9.4%). The service category was also the most concentrated within the CBD (40.0%), followed by transportation, public buildings, and retail (all about 14%), and manufacturing (4.2%).

DIETER BRUNNSCHWEILER—*Periglacial Features in North America and Their Climatic Implications*

Climatic geomorphology has barely begun to realize its potentialities in clarifying the relationship between climate and geomorphic evolution during the Ice Age in nonglaciated areas of North America. Not only did drastic changes in surface configuration occur in *terra glacialis*, but most landforms of the present day, glaciated or not, are the result of Pleistocene morphogenesis.

This study analyzes the climatic implications of fossil periglacial features in North America. Field work and a survey of literature on the subject indicate a variety of landforms which owe their origin to processes of the morphogenetic cycle of solifluction ("periglacial cycle"), most of them in a zone of varying width along Wisconsin terminal moraines (Appalachians, Central Midwest, Driftless Area, Great Plains, Rocky Mountains, Columbia Plateau). Special reference is made to silt mounds and tongues, surrounded by stone nets, occurring over a large area of the Columbia Plateau. If the pollen-analysis record has not ascertained tundra adjacent to the ice, the geomorphological evidence for such a zone is conclusive. Scattered permafrost phenomena were also encountered within Wisconsin drift which makes it plausible to assume at least limited solifluctional activity along the receding ice margin.

These and related phenomena (snow line, loess, biota) permit inferences as to the thermal regime in the periglacial area in particular and the climatic differentiation over Pleistocene North America in general. The paleoclimatic map presented is meant to serve as a basis for much-needed further work in climatic geomorphology.

JOHN E. BRUSH—*The Succession of House Types and Styles in Central New Jersey*

Analysis of American domestic architecture may be undertaken in three ways: regionally, typologically, or chronologically. In a regional analysis the objective is to ascertain the distinctive types of houses or farmsteads which set apart one area of the country from all others. In a typological analysis a particular type or manner of building is traced wherever it is to be found. In a chronological analysis

the houses or farmsteads and other used structures in an area are examined and their chronological order is determined. If one were to map and classify all settlement in any given area on the chronological basis, the data required for complete regional and typological treatment would also become available.

The small towns, villages, and rural or suburban townships in central New Jersey lend themselves to chronological analysis because original settlement occurred fairly early in the Colonial period—about 1670–1700. Subsequent changes in the culture and growth of the population are expressed in the succession of house types and styles to be observed today. Evolution of the common dwellings from about 1700 has been analyzed in terms of eleven eras. Old maps, tax lists, and original census records have been found to be essential adjuncts to chronological settlement study.

The results of such an analysis not only provide the facts and time perspective necessary for testing theories of settlement morphology, but also will become the basis for comparative study of the regional distribution or evolution of house types elsewhere.

WESLEY C. CALEF—*Winter Air Mass Climatology of the Northern Great Plains*

Various proposals have been made for an air mass climatology, i.e., a description of the weather and climate in terms of the frequency and duration of air masses from different sources occurring at a station or over an area. A few studies have been made using air mass data.

Climatic description by means of air mass data is subject to several major difficulties. First, air masses even in their source regions do not have the same properties from one day or month to the next. After they leave the source region air masses are subject to widely varying degrees of modification. Moreover, the classification of air masses itself is subject to much variation. Also, difficulties are frequently encountered in classifying the air mass over an area. Finally, days with frontal passages present problems of classification that have never been satisfactorily resolved.

In this study air masses are tabulated, classified, and statistically described for four northern Great Plains stations for ten winters. The difficulties and problems discussed above

are exemplified and analyzed. It is concluded that air mass climatology can probably best be used for purposes of qualitative climatic description. However, it is adjudged of little use for quantitative description of weather elements at a place because the values obtained by statistical summaries classified according to air mass (1) are no more revealing than are classical values such as means, deviations, frequencies, and variabilities, (2) are subject to wide variations of values within each class, and (3) are subject to great ambiguities because of uncertainties arising out of air mass classification problems.

ALBERT S. CARLSON—*The Spread of Industry into Inland New England—An Example from the Upper Connecticut Valley*

The attractiveness of the coastal and marginal areas of New England as profitable sites for industry and pleasant vacations continues but there is the beginning of a movement into the interior. It is spurred by the decrease in suitable industrial and recreational sites in southern and coastal New England and by the new interstate and defense highways which put most of the populated area of middle and northern New England within a few hours' driving time of the rich markets and excellent seaports in the Middle Atlantic States.

Recent developments and trends in business growth in the Upper Connecticut Valley of New Hampshire and Vermont provide case histories that show the causes of this movement away from the coasts and into the middle of New England. Among the factors combining to create rapid growth of the relatively undeveloped industrial and recreational resources of the Upper Connecticut Valley are the long stretches of unoccupied shoreline of the Connecticut River and its hydro-ponds, the convergence of new interstate and defense highways on the valley, an excellent supply of cooperative labor, and the lack of sufficient facilities in the Lower Connecticut Valley to contain the high predictable increase in population and industrial jobs and the resulting demand for recreational facilities.

ROBERT L. CARMIN—*Forest Versus Grassland Soils of Central Brazil*

A great extent of Brazil is covered by tropical forest and by *cerrado*, a savanna-like scrub

vegetation. Numerous writers and researchers claim that these vegetative types are indicative of soil quality. The consensus is that areas covered by forest have soils far superior to those covered by *cerrado*. This conclusion is based on tests made of relatively few soil samples gathered over extensive areas, and observations of the results obtained through trial-and-error planting.

To test these conclusions I made field studies in Goias State during the summer of 1956, and used maps and aerial photographs to select two apparently typical sample study areas—one a forested region, the other a *cerrado* type. The two sample areas were divided into seven "landtypes" (subdivisions having the same topographic expression together with the same associations of soil and natural vegetation). Soil samples apparently representative of each landtype were taken and analyzed in the laboratory.

The results of the soil tests and field observations led to the following conclusions: (1) the forested areas of central Goias generally have more fertile soils than the *cerrado* areas; (2) exceptions to the rule exist in both areas; that is, some landtypes in the *cerrado* areas have fertile soils and some landtypes in the forested areas have soils that are relatively useless for crop production; (3) even the best soils of the forested area, however, have their shortcomings. They tend to be on the acid side, they are low in total nitrogen and potassium, and are very low in phosphorus; and (4) a more thorough scientific study of these soils must be made before truly sound conclusions can be drawn. Present judgments are based on a relatively small number of soil samples taken over a vast area, and tested by methods valid in mid-latitude areas but possibly not applicable in the tropics.

HANS H. CAROL—*Current Geographic Thought in the German Language Area*

There is some tendency to stabilize the present position in geographic philosophy. Nevertheless, critical thinking about geography continues because geographers are not yet decided on the final goal of their science. To overcome this situation, German, Austrian, and Swiss methodologists have published numerous articles on that field in the last decade. Without considering the manifold aspects

involved, we shall explain two different basic ideas on the object of geography.

1. Most of the German-speaking geographers consider the object of geography to be "Landschaft" in the sense of "total region"; or, more precisely, areas of natural as well as cultural homogeneity. This concept of "Landschaft" is opposed not only by the American but also by some of the German-speaking methodologists.

2. Another concept of the object of geography is seen in the complex of "earth layers" rather than the earth's surface. The complex of layers, called the geosphere, consists of the lithosphere, hydrosphere, atmosphere, biosphere, and the anthroposphere. As a rule, geographers do not study the geosphere but select a segment of it called a "geomer." This term means the totality of all existing phenomena in any segment of the geosphere. Specific examples of geomers are North America, the Appalachians, Pittsburgh, the Tennessee Valley, Pennsylvania, the United States, and so forth. The science of geography develops systems of approach which help its followers to study geomers.

GEORGE F. CARTER—*Origin of Easter Island Writing*

That Easter Islanders possessed writing was belatedly recognized in 1868. By that time slavers and disease had reduced the population from about 2500 to 111 people. The art of reading and writing virtually perished with this physical collapse, and attempts to save the situation were bungled. Only 24 examples of the writing survived, and only one set of meaningful transcriptions was made. The scholarly conclusion was reached that this was not writing, but rather an elaborate decoration.

Subsequent work now shows: (1) that the script is writing; (2) that its traces are discernible westward across the Pacific to Malaya; (3) that the trail leads from there to Ceylon, Central India, and finally to the Indus Valley civilizations of 2500 B.C. Eastward there are tenuous links to America. Currently the Easter Island script is being deciphered by a German, using modern ciphering techniques. Two new texts collected by Heyerdahl seemingly will be important additions.

It now seems clear that people who carried writing were making voyages most of the way, if not all of the way, across the Pacific in remarkably early times. Radiocarbon dates for Polynesia already reaching back to B.C. begin to suggest the time scale involved.

RICHARD E. CARTER—*A Comparative Analysis of United States Ports*

Geographers have long been interested in developing techniques by which ports may be compared and classified. Many detailed studies have been carried out on individual ports but there seems to be no scale whereby the activities or relative stature of any given ports can be measured and compared.

The object of this paper is to examine a number of the often-discussed aspects of traffic for 60 United States ports. Each port handling more than four million tons of commerce in 1956 is represented on a series of maps evaluating the following traffic characteristics: (1) the total tonnage handled; (2) the type of traffic—foreign, coastwise, lake-wise, internal, and local; (3) the export-import ratio or balance of traffic flow; (4) the major commodities handled; (5) the variety of commerce; and (6) the value of foreign commerce.

An examination of these maps reveals a number of generalizations, among them the following: (1) The tonnage of all the ports is dominated by bulk commodities, and a surprising number are essentially one-commodity ports with a correspondingly strong one-directional flow. (2) Petroleum is the leading commodity for all but a few of the coastal ports but is relatively unimportant among those of the Great Lakes. (3) There is a marked concentration of foreign commerce in a few ports. (4) The total tonnage alone is not a satisfactory criterion for assessing the relative rank of a port; the diversity and value of its commodities must also be taken into consideration.

This paper presents the picture of the dominance of bulk commodities and their distribution among United States ports. It represents a first step in classifying ports by the composition of their traffic. Findings indicate that a necessary next step is a similar analysis of the very important general cargo classes.

ROY CHUNG—*Population Growth and Redistribution in the British West Indies*

Population growth rates of the British West Indies before the twentieth century were largely determined by fluctuations in one demographic variable, differential migration rates. Since the turn of the century the rates of growth have been conditioned primarily by the interplay of a decreasing death rate and a slowly declining birth rate, rather than by migration. The last decade has been characterized by an accelerated population growth triggered by a rising birth rate and a rapidly decreasing death rate.

Drawing mainly from data pertaining to Jamaica, Barbados, and Trinidad, this paper first traces the broader secular trends in the rates of population growth, and analyzes the changing nature of the demographic processes underlying these differential rates. Evidence is produced to support the thesis that the recent accelerated population growth has been accompanied by an increasing birth rate, and that this is not merely a statistical increase but a real increase in the birth rates.

Secondly, the patterns of intra-island population movements and the associated changes in the areal patterns of the major population characteristics are analyzed comparatively for the three islands. The areal patterns are then related to specific social and economic conditions which are known to be both spatial and temporal correlates of these changes.

NELSON C. CLARK—*The Continuous Habitation Patterns of India and Pakistan as a Cartographic Problem*

A unique population settlement pattern exists in the densely populated areas of the rural, agricultural subcontinent of India and Pakistan. The demographic distribution is arranged according to a dense stipple of homesteads and tiny hamlets, rather than by the village pattern commonly characteristic in other parts of Eurasia. The foundations of such unusual continuous habitation patterns are embodied in the academic disciplines of economic, historical, political, sociological, and climatological geography. Thus, an interesting, challenging portrayal problem was created for the professional aeronautical cartographer. A number of alternative methods of portrayal were tested. It is expected that

the portrayal selected will substantially improve the quality of aeronautical charts.

SAUL B. COHEN AND WILLIAM APPLEBAUM—*Evaluating Store Sites and Determining Rents: An Aspect of Applied Geography*

Businessmen are sometimes called "the most practical kind of geographers." Surely, determining industrial or commercial locations involves the study of various production and market elements from the uniquely geographical standpoint. But if businessmen do not utilize geographical tools of location analysis, then they are acting as practical geographers in a most impractical manner.

In modern retailing, selecting and evaluating store sites is a phase of applied geography that should rely upon orderly location research methods. Such research is still in its infancy, lacking completeness in raw statistical and other data and sufficient practical standards for comparative evaluation. What is most needed are more store location facts about existing retail establishments and their trading areas, to provide an empirically derived base for store location principles.

The most pressing reason for a retailer's desire to evaluate a store site is to determine sales, profits, and the rents that he can afford to pay. By evaluating a site and its service area, such information can be provided. This paper presents some of the geographical methods and tools that can be applied to the evaluation of such elements as accessibility, population, competition, associated stores, economic stability, and trading area boundaries. Such evaluation can shed light upon store operating considerations, rental factors, lease negotiations, and management policies as to store development programs. Store location data such as these, combining evaluation and integration, will eventually supply the material for the broader concepts and theoretical formulations of store location science.

JOHN C. COOK—*Antarctic Exploration and Development in the Coming Half-Century*

The past 50 years have seen the application of radio, aircraft, icebreakers, geophysical prospecting methods, and, finally, efficient mechanical oversnow transportation to polar exploration. However, there is great need for improvement of the existing techniques, and

for the development of new ones. In all probability, more major inventions will be brought to bear on the exploitation of Antarctic resources in the next 50 years than during the past 50. Some such inventions can already be foreseen. There appears to be a possibility that the depth and character of the rock floor beneath the continental ice sheet can be determined by electromagnetic methods from an aircraft in flight. It is anticipated that most of the Antarctic continent will ultimately be explored in detail by this and other continuously profiling, airborne geophysical methods.

Exploitation of sub-ice mineral deposits may become possible through advanced ice-drilling and tunneling methods, or by means of liquid-phase extraction methods analogous to the Frasch process used in the recovery of sulfur. Self-supporting Antarctic communities will become possible when adequate energy can be developed locally, either by nuclear-fusion methods or by utilization of indigenous fuels, possibly by an in-place, partial-combustion process. The harvesting of adequate food from the sea, or its production locally, may become possible as a result of research now in progress. The use of indigenous building materials, particularly rock, appears practicable for permanent Antarctic housing.

The successful application of research and invention to polar problems requires extensive field testing under polar conditions, and repeated modifications by expert personnel in well-equipped shops. This process could best be performed at permanent scientific stations, which in turn would become more efficient as a result of the inventions. Thus man may ultimately obtain not only priceless scientific secrets, but living-space of unique beauty and generous material riches from the largest remaining undeveloped land-mass on earth.

ROBERT E. CRAMER—*Agricultural Developments on the Pamlico Peninsula, Eastern North Carolina—A Study in Drainage Reclamation*

The Pamlico Peninsula of eastern North Carolina, an area twice the size of Rhode Island, is today undergoing extensive reclamation and agricultural expansion. Located in the "Flatwoods," or Outer Coastal Plain, it has remained for years an isolated area of

swamp and forest, as well as an area of low income and declining population.

Drainage control and cultivation started before the Civil War in a few scattered places, but extensive land developments have taken place primarily within the past five years. Land tracts of as much as 100,000 acres have been purchased by individuals and land development companies in recent years, and approximately half of the peninsula is either in cultivation or is being developed for cultivation. Cropland that sold for 50 cents an acre several years ago now is valued as high as \$200 an acre, and areas that were formerly impassable swamps today support mile-long rows of soybeans and corn.

Several factors have contributed to the development of the peninsula: a favorable growing climate, organic soils, minimum erosion, construction of drainage ditches, level land which has encouraged mechanization, and proximity to markets. However, the recent developments are primarily inherent in the availability of capital for land development, the proven usefulness and availability of heavy machinery needed for extensive land development and cultivation, and the successful techniques of swamp farming acquired by local farmers.

The alarming economic and population decline of this area apparently is over, as miles of swamps and forests are being replaced with productive cropland and pasture.

RICHARD E. DAHLBERG—*Recent Developments in the Chautauqua-Erie Grape Industry*

Recent developments in the marketing structure of the Chautauqua-Erie grape industry provide an interesting conclusion to the first century of commercial production in this belt-like area which straddles the Pennsylvania-New York boundary along the Lake Erie plain. Launched on a commercial basis in 1859, the grape industry of the area has experienced both boom and "bust" as market outlets and conditions changed. For the past two decades local processing plants have dominated the market for Chautauqua-Erie grapes. Almost entirely Concord, these grapes are converted chiefly into unfermented juice.

In 1956, a single cooperative, comprising more than 4000 Concord grape growers in the

Chautauqua-Erie area and in several other districts, completed the purchase of the nation's largest unfermented grape juice company. Grape growers thus acquired a network of nine modern processing plants, a well-organized distribution system, an established brand name, and a successful advertising and sales program. They succeeded thereby in consolidating the Concord grape industry, setting an unusual but significant example of vertical integration. Through the nation-wide facilities of this organization, juice and other grape products from the Chautauqua-Erie area are sold throughout the nation and in several foreign countries as well. Thus, the Chautauqua-Erie area enters its second century of commercial grape production on an optimistic note.

PAUL C. DALRYMPLE—*The Quartermaster Corps Microclimatic Program in Antarctica During the IGY*

The Quartermaster Corps Research and Engineering Command, in conjunction with the Signal Corps, initiated an extensive microclimatic program at certain U. S. Army Test Sites in Alaska, the Canal Zone, and the United States in 1955. This program was extended during the IGY to include, among additional sites, the Antarctic. A microclimatic program was conducted at Little America V on the Ross Ice Shelf in 1957 and at the Scott-Amundsen South Pole Station on the Polar Plateau in 1958. Temperature measurements at seven depths (—800, —250, —50, —25, —10, —5, and —2 centimeters) and at ten heights (surface, 3, 6, 12, 25, 50, 100, 200, 400, and 800 centimeters) were recorded continuously. Wind profiles at six heights (25, 50, 100, 200, 400, and 800 centimeters) were measured on most days. Never before in the Antarctic has such a density of temperature and wind measurements been made in the layers immediate to the surface. Surface inversions to 8 meters of 35°F. and 26°F. were measured at Little America and the South Pole, respectively. Upper air soundings showed inversions off the surface as high as 70°F. at the Pole Station. Little America experiences considerably gustier winds than those encountered at the Pole, although seasonal averages are approximately the same. Windiest hour measured at 8 meters at Little

America was 27.5 meters per second, at the Pole Station 16.3 meters per second.

This paper, based upon the author's two-year experience in the Antarctic conducting the program, deals with the instrumentation, environmental problems, surface inversions, and wind structures. Certain comparisons are made between results from the Ross Ice Shelf and from the Polar Plateau. Additional comparisons, as information is available, are made between conditions and results from the Norwegian-British-Swedish Expedition to Maudheim on the Weddell Sea, 1949-51, from the British Transantarctic Expedition, 1957-58, and from the Russian IGY Station at Mirny in Wilkes Land, 1957-58.

LUELLA N. DAMBAUGH—*The "Hole in the Donut"—A Microcosm*

When mention is made of the "Hole in the Donut," the reference is to the area of privately owned agricultural land in South Florida completely surrounded by the vast Everglades National Park. Several features, interrelated and in juxtaposition, give uniqueness to this region. (1) This area has been, and will continue to be, surrounded by frontier. (2) It is the southernmost economically cultivated land in the United States. (3) The entire production of out-of-season vegetables moves into commercial channels. (4) Freezing temperatures have never been recorded. (5) Nearly level land, originally covered with longleaf pines, only a foot or two above mean sea level, lends itself to mechanized operations. (6) Extreme isolation, seldom an advantage elsewhere in the world, makes for safety in aerial spraying and frost flying. (7) Migratory labor fulfills all the man-hour requirements, except for the top echelon of supervisors and machine operators. (8) The southernmost labor camp in the nation houses Puerto Rican and Texas-Mexican migrant workers.

GEORGE F. DEASY—*Regional Differences in Primary Energy Sources for the Generation of Electricity in Pennsylvania*

Almost no attention has been directed by American geographers to one of the most important sources of power in the world—electricity. Many aspects of the electric generating industry have no geographic signifi-

cance, being of interest instead to engineers, economists, users of electricity, stockholders, and lawmakers. But certain facets of electric generation are primarily geographic. One such facet is the matter of competing primary energy sources employed in the production of electricity. This paper analyzes the subject of regional differences in such energy sources in a 45,000 square mile territory—the Commonwealth of Pennsylvania.

Five types of primary energy are employed to generate electricity in the Commonwealth: bituminous coal, anthracite coal, water power, fuel oil, and natural gas. Each type of primary energy is employed exclusively in one or more energy zones or nodes within the Commonwealth, and in a number of instances multiple energy types result in mixed or transitional energy zones or nodes. Most such energy zones or nodes, both single and multiple, are shown to be the product of a variety of interacting geographic factors. These factors result in regional variations in competitive energy costs and hence in primary energy types. The cost element, however, is negated in a few areas by historical inertia and/or the element of cleanliness and convenience.

Several primary energy types are obtained from areas both within and without the Commonwealth. Regions in which out-of-state energy competition exists are identified and explained.

DAVID J. DE LAUBENFELS—*Australian Forests Compared with the Vegetation of Similar Climatic Areas in the Americas*

In the development of plants and animals, Australia has been the most isolated in recent times of all comparable areas in the world. It was therefore felt that a comparison of Australian forests with the vegetation of analogous climatic areas in other parts of the world would be a good test of generalizations about vegetation morphology. Specific comparisons have been made between Australian and American forest formations. The rainforests of Australia are not unique because they have close relationships with rainforests elsewhere. Nearly all other forests in Australia are dominated by various species of eucalyptus. The amazing fire resistance of the eucalypts and their associated plants has resulted in a prevalence of forest in spite of

frequent fire. Even though the majority of Australian trees are totally unrelated to corresponding trees in North and South America, many important physical features that the forests display are paralleled in the New World.

FERNAND DE PERCIN—*IGY Investigations at Lake Peters, Mt. Chamberlin, Brooks Range, Alaska, During the Summer of 1958*

Geophysical investigations were conducted at Lake Peters, in the Brooks Range, Alaska, from June to September, 1958, as part of the IGY. The six-man party consisted of a geologist, a hydrologist, an ecologist, a glaciologist, a meteorologist and a communications specialist. Two camps were established, one at the base of Mt. Chamberlin on the east shore of Lake Peters, at an elevation of 2980 feet, the other on Chamberlin Glacier, at an elevation of 6300 feet.

During the summer, the geomorphology of the area was studied and the surficial geology was mapped. Hydrological measurements were made at the snout of Chamberlin Glacier, at the several streams emptying into Lake Peters and Lake Shrader, and at the lakes themselves.

The flora and fauna of the area were studied and listed, and limnological investigations were conducted in the two lakes. Meteorological stations were established at the Lake Peters base camp and on Chamberlin Glacier. At these stations, standard surface weather observations and solar radiation and temperature gradient measurements were made on a regular basis.

WALTER DESHLER—*Livestock Trypanosomiasis and Human Settlement: Some Relationships Observed in Northeastern Uganda*

Tsetse fly frequently limits the location and density of population in the semiarid areas of Africa south of the Sahara. This paper is concerned with the influence of livestock trypanosomiasis, a disease transmitted largely by the *Glossina morsitans* species of tsetse fly. Recovery of livestock from the disease is extremely rare. Most of the inhabitants of these semiarid lands subsist by some mixture of cattle-keeping and shifting agriculture. The advent of tsetse infestation in a settled area forces them to evacuate.

The influence of tsetse extends well beyond

the area of infestation and its effects may endure for decades. The paper examines these aspects of a tsetse invasion into land of the Dodos, a tribe which occupies 3000 square miles of highland in northeastern Uganda.

When western Dodos country was invaded by tsetse from the Sudan during the late 1920's, the inhabitants retreated to the south and east to settle among their fellow tribesmen in eastern Dodos country. Since further migration in any direction was not possible because of hostile neighbors, the settled areas became crowded and gradually deteriorated. Tsetse clearance was started in Dodos during the late 1940's; by 1954 most of the area was free of tsetse. A cautious movement of people and herds into the newly cleared lands has taken place. There is not enough cleared land, however, to relieve the overcrowding. Questions raised by the interrelation of tsetse and people are discussed.

AUBREY DIEM — *A New Route Through the Alps: The Mont Blanc Tunnel*

In today's era of cosmic penetration the earth's physical barriers remain obstacles to man's intercommunication. One of these barriers, the Mont Blanc Massif, is finally being pierced by construction of a 7.3-mile vehicular tunnel connecting Entrèves, Italy, with Chamonix, France. That the Mont Blanc Tunnel is a necessity has never been denied. As early as the turn of the century there were many advocates of the project, but construction was delayed by regional and national differences and by the two World Wars.

When the tunnel is opened to motor traffic in 1961, an essential addition to north-south and east-west communication and transportation in Europe will come into being. Trucks and automobiles will be able to travel the most direct all-weather routes through the Alps along the London-Paris-Rome and Venice-Milan-Bordeaux highways. At present, motor vehicles traveling north from Milan and Turin through the Val d'Aosta to France or Switzerland must cross the Alps over the steep Little or Great Saint Bernard passes. Both are closed for six to eight months of the year.

The inauguration of the Mont Blanc Tunnel will help relieve the increasing automobile congestion, precipitating delays of four hours

or more at Alpine customs stations. It will also end the semi-isolation of the Autonomous Region of the Val d'Aosta and tighten the bonds of the European economic community.

FRED E. DOHRS — *Changing Land Use Patterns in the Central Ukraine*

This study is based on a land-use traverse made by car across the central Ukraine from north to south and return, in May, 1958. The Ukraine, traditionally and because of climate and soils, has been primarily a grain producing area (75 percent of sown land), chiefly winter wheat. At present, however, the percentage of grain area is declining, an increase of meadow and pasture land is evident, and large areas are being planted with fruit trees in a curious but systematic pattern. These changes are accompanied by a tremendous effort to collect and conserve water through a variety of methods, including the construction of huge dams, the creation of small ponds and basins by earth walls, and an attempt to raise the water table wherever possible. Large herds of young cattle, including heifers and steers, are pastured in the vicinity of the ponds and reservoirs. All these efforts toward conservation and diversified production are associated with land management and cultivation practices of the most appalling sort. The over-all picture is that of a gigantic gamble to transform an entire region from a grain economy to a cattle-feeder and dairy economy.

JOHN E. DORNBACH — *The Mental Map*

All normal individuals possess the ability to form schematic mental maps of routes to and from familiar places. It is also possible to form mental maps through study of places never visited. Contrary to the very refined mental maps of the geographer, it is not exceptional to find intellectual individuals with such poor mental maps that they have little concept of the relative position of continents. The mental map formed in our mind is called a "topographical schema" by the psychologist.

The schema is evidenced when we think of the route from office to home or when we attempt to give route directions to a stranger. We use a mental map when moving about our homes in total darkness. Although we cannot see, we are aware of relative distances and

directions. From this it should be readily understandable how difficult is the problem of creating a schema in the mind of an individual who has been blind since birth.

Pilots and navigators have known for years that the better the mental map is established through preflight study, the easier is pilotage navigation during an actual mission. Present research is even examining the possibility of utilizing auditory cartographic information to supplement or "jog" the mental imagery formed through previously learned graphic or textual materials.

As the cartographer studies methods by which proper mental maps can be created in the minds of the map user, he begins to approach the realm of the geographer whose forte is to teach the location and distribution of geographic phenomena. Through an analysis of the requirements for establishing an adequate mental map in the minds of the user, the cartographer is led toward fundamental principles of design. It is postulated that better maps and charts will result if the major emphasis in cartographic design is placed on the discovery of principles and methods by which the framework for an adequate and geographically satisfactory mental map can be constructed in the mind of the user.

GARY S. DUNBAR—*A History of the Regionalization of Virginia*

This paper attempts to delimit the popular regions of Virginia—"The Eastern Shore," "The Northern Neck," "The Shenandoah Valley," "The Southside," "Southwest Virginia," and others. The regional names are "popular" in that most of them have been long in use and certain connotations have been ascribed to them, but they cannot be considered folk terms because they apply to rather extensive areas and did not originate with the "folk." Also considered are the rather recent names, including those employed in physiographic descriptions. The paper is concerned with the origin of the names, their spatial applications, and their role in promoting regional consciousness. Some generalizations are attempted concerning the naming of popular regions in the United States.

SIGMUND J. FALKOWSKI—*Climatic Frequency Data for the Northern Hemisphere*

Engineering requirements for climatic data more detailed than mean values have resulted in a study of generally less commonly available climatic frequency data.

The nature and scope of a recently assembled collection of frequency data for the Northern Hemisphere are presented. The collection of data, tabulated for the U. S. Army Quartermaster Corps by the USAF Air Weather Service, includes frequencies of temperature, wind, cold-wet conditions, and surface conditions for 326 stations in the colder regions of the Northern Hemisphere. Tabulations for Dickson Island, U.S.S.R., are used to illustrate the various frequency distributions, and analyses of temperature frequency maps for North America are presented.

HERMAN R. FRIIS—*Highlights of Geographical Exploration and Mapping of the Arctic by American (U. S.) Expeditions Prior to 1910 Whose Primary Objective Was to Reach the North Pole*

On April 6, 1909, Commander Robert Edwin Peary (USN) rested his small advance party on the ice after a remarkable sledging trip of 37 days from Cape Columbia on the northern tip of Ellesmere Island. His observations indicated that he was at or near the Pole. However, in order to make certain that he had achieved his goal—the North Pole—he interlaced the general area with a series of position observations for the record.

On April 6, 1959, we commemorate Peary's "attainment of the Pole." It seems appropriate on this occasion to summarize the geographical and cartographical achievements of Peary's progressive approaches to the point of tangency at ninety degrees north latitude and also those of other American explorers whose acknowledged goal was the North Pole. During these explorations much terrain information was acquired and many field maps were made which, when given to mapping agencies of the federal government, especially the Hydrographic Office, corrected and greatly expanded our knowledge of the shape of the Arctic.

For the sake of convenience this summary is divided into four parts: (1) the period prior

to about 1850; (2) 1850-1875; (3) 1875-1910; and (4) the expeditions of Peary. The large part the American Geographical Society played in these expeditions is emphasized. The paper is illustrated with black and white and colored slides of the original records, many of which, especially recently discovered Peary maps, are among the records in the National Archives.

ROLAND J. FUCHS—*Intraurban Variation of Residential Quality*

Cities have been observed to differ in the degree of internal or intraurban variation of residential quality that they exhibit, i.e., some cities appear fairly uniform in quality while others are more varied. This study was concerned with measuring the degree of intraurban variation in residential quality in a number of cities, noting whether differences in this characteristic from city to city had any regional pattern, and determining whether these differences were associated with differences in certain urban, social, and economic characteristics.

The 1950 Census of Housing provided the basic data. Housing cost as measured by monthly contract rent or a rental equivalent was selected as the most satisfactory available indicator of quality. The coefficient of variation was chosen as the most suitable measure of relative variation, and was computed for 209 United States cities on the basis of housing costs. Correlation and variance analysis were employed to see whether the coefficients were associated with a variety of urban characteristics.

It was concluded that cities differ significantly in the degree of intraurban variation of residential quality. Regionalization was evident; cities of the Southeast and New England were the most varied and cities of the West, Northwest, and the Great Lakes area the least varied. A number of urban characteristics were found to be significantly associated with the coefficients of variation. Most significant were a moderately high, direct association with the percentage of low-income families and a moderate negative association with the percentage of dwelling units that were owner-occupied.

ROBERT E. GENSLE — *The Suez Canal and Middle East Oil*

In 1859 the Suez Canal was opened to traffic and a new sea route connected the North Atlantic and Indian oceans. Today this route has become one of the major oil arteries of the world. Ocean tankers plying the Suez Canal sea route carry crude oil from the Middle East petroleum fields to the markets of Western Europe and the United States.

The Suez Canal is a vital link in this ocean tanker route. Navigation through the 100-mile-long canal is affected by conditions that are inherent to restricted waterways. Furthermore, the nature of tanker cargo requires additional precautions in navigating the fairway. A pilot and convoy system has been successful in facilitating the passage of ships through the canal. Extensive improvement programs have been necessary to keep pace with the increase in size and draft of ships. At present, tankers up to approximately 32,500 tons can use the canal. This excludes many large tankers constructed in recent years.

The Suez Canal is a critical factor in the future utilization of this tanker route for the shipment of Middle East oil. A major consideration is the ability of the Egyptian Canal Authority to undertake major improvements to the waterway. Another consideration is competition from the Cape of Good Hope sea route around South Africa and the pipeline routes in the Middle East. The impact of the closure of the canal in 1956 has stimulated plans for bypassing the waterway, including a proposed pipeline across southern Africa.

L. A. PETER GOSLING — *Recent Introductions of Plants and Animals into Northeastern Malaya*

Almost all the plants and animals brought into northeastern Malaya in the last century are deliberate introductions into an already richly varied flora and fauna. This paper deals with the principal items introduced, their origin, and the means and motives for their introduction. The area considered is limited to the agricultural lands of the delta of the Trengganu River.

Trengganu Malays are excellent horticulturists and often accumulate large collections of exotic plants in their backyard gardens. Their habit of collecting plants, together with

their wide wanderings in southeastern Asia, has resulted in the haphazard introduction of numerous kinds of garden plants and trees, not all of which serve a useful purpose in the economy.

Much of the history of plant and animal introduction is preserved by word-of-mouth or legend, which provides detailed information about the point of origin, date, and circumstances of introduction into Trengganu. The instances most vividly recorded are those in which specific plants have been sought in other parts of Southeast Asia. The most common of these concern the searches for varieties of rice that contain certain specific characteristics. Historically, animals for breeding and for sporting purposes have been introduced from as far away as Saudi Arabia.

During the colonial period, governmental departments were the chief agencies of plant and animal introduction. The easy availability of new plants and animals at official experimental stations has brought a changed point of view to the native farmer. He no longer brings in novelties and then tries to determine what possible use can be made of them; now he takes a critical, if nonexpert, view of the governmental importations and finds many reasons to reject what formerly he would have accepted freely.

PHYLLIS R. GRIESS—*Localization of High-Efficiency Coal Mines in Western Pennsylvania*

There are significant differences in the importance of localizing factors for high-efficiency strip and underground mines in the bituminous coal fields of western Pennsylvania. High-efficiency mines are here defined as those mines approximating or exceeding the 1953 state average man-day output for each type of mine.

High-efficiency strip mines are widely distributed throughout western Pennsylvania's coal fields, with at least one such mine in almost every bituminous coal-producing county. This widely dispersed pattern indicates that the existence of such mines is not primarily dependent upon locally present favorable factors. There is, however, a definite concentration of the high-efficiency underground mines. Almost all of these mines are located in eight counties in the southwestern part of the Commonwealth, where are found

most of the thicker bituminous coal seams, the principal navigable rivers, and western Pennsylvania's major industrial markets for coal.

Differences in the significance of localizing factors for the two types of mines are closely related to mining costs, which are higher on a per ton basis for underground mines than for strip pits. Owing to lower cost of operations, high-efficiency strip mines can be operated profitably in all parts of the coal fields, whereas high-efficiency underground mines must have one or more of the advantages conferred by the presence of thick coal seams, location close to major markets, and/or availability of cheap water transportation in order to remain competitive with the more cheaply operated high-efficiency strip mines.

THOMAS M. GRIFFITHS—*Observations on the Regime of a Dry Polar Glacier*

The P-Mountain Glacier is a small isolated ice body separated from the Inland Ice, near Thule in northwest Greenland. Observations on the P-Mountain Glacier indicate a pattern of retreat which more nearly characterizes the regional climatic regime than does the behavior of the marginal zones of the Inland Ice in the same locality.

Annual ablation measurements indicate a steady net loss of moisture. This net loss is several times the total measured annual accumulation for the region. Since the elevation range of the Thule Lobe of the Inland Ice is roughly comparable to the elevation range of the P-Mountain Glacier, comparisons between the two, based on the location of the firn line (line of accumulation-ablation balance), seem justified. It is found that the firn line on the Inland Ice lies at an average elevation of 635 meters above sea level, while most of the P-Mountain Glacier, which has no firn line, lies above this elevation.

The entire surface of the P-Mountain Glacier is being lowered more rapidly by ablation than is that portion of the Inland Ice which lies below the firn line. Surface movement measurements on the Inland Ice indicate that some of the losses to ablation are being offset by the outward transportation of fresh ice from the interior.

These observations seem to strengthen the contention that the regime of a detached dry

polar glacier is a far better measure of regional climatic anomalies than is the marginal zone of an ice cap.

LEE GUERNSEY—*The Reclamation of Strip-mined Lands in Western Kentucky*

Strip coal mining in western Kentucky has left about 15,000 acres in spoil banks. Prior to 1954, there were no legal requirements to reclaim strip-mined lands in Kentucky; consequently, about 80 percent of the strip-mined lands were without substantial stands of vegetation. Since 1954, about 6000 acres of spoil banks in western Kentucky have been graded and revegetated by strip coal mining companies.

This paper analyzes salient characteristics of recent grading and revegetation practices in western Kentucky. Grading effects are controversial. Opponents to grading practices state that any leveling causes excessive compaction on the spoil banks. Density tests taken by the author reveal that grading of spoil banks does not cause excessive compaction. Rather, results of density tests taken in four counties in western Kentucky revealed that they have a density varying from 68 percent to 93 percent of that in adjacent unmined lands.

Prominent practices of revegetating the strip-mined lands in western Kentucky are cited. Early tree plantation and areas seeded to grasses and legumes are described. Finally, the outlook of reclaimed strip-mined lands in western Kentucky for future productivity in forestry, pasture, and wildlife is briefly examined.

ROBERT A. HARPER—*The Impact of Political Factors on Manufacturing in the Illinois Portion of the St. Louis Metropolitan Area*

Madison and St. Clair counties, Illinois—the two counties that form the Illinois portion of the St. Louis Metropolitan Area—encompass one of the major displays of heavy industry in the country. Manufacturing in the two counties provided employment for more than 55,000 workers and totaled more than \$500,000,000 in value added in 1954. Seven out of every ten manufacturing employees work in heavy industries. The area is the primary metals center and petroleum refining district of the St. Louis Metropolitan Area and is a

major producer of glass, chemicals, and meat products as well.

The area, 40 years ago one of the most rapidly growing manufacturing districts in the country, has lagged badly in growth since 1920. Plant obsolescence, changing technology, community social problems, and changing raw material accessibility are usually given as causes of this lag. This paper points out that former "physical" advantages were often the result of political rate and cost factors based on the division of the Metropolitan Area between two states. Such advantages are now gone, but the political division at the Mississippi River remains a factor affecting manufacturing. Not only is the political disunity of the metropolitan community into two states an important consideration to area manufacturing, but the division of the Illinois portion into two counties and numerous small communities has important implications as well.

JOHN FRASER HART—*Censal Year of Maximum Negro Population in the Eastern United States*

Although counties in various parts of the eastern United States recorded maximum Negro population at different dates, the maximum was reached simultaneously in contiguous groups of counties with an interesting degree of regional concentration. Mapping the censal year when each county attained its maximum Negro population gives new insight into the redistribution of the nation's Negroes.

In 1880 the maximum Negro population was recorded in most of Virginia, Kentucky, Missouri, and central Tennessee. In 1890 and in 1900 the maximum Negro population was attained in the remaining Appalachian counties, in the Alabama Black Belt, along the lower Mississippi, and in parts of eastern Texas. 1910 was the year of maximum Negro population in many counties of the Georgia Piedmont, eastern Oklahoma, and counties fringing the Black Belt and the Mississippi "Delta." In 1920 maxima were recorded for much of the Coastal Plain in South Carolina and Georgia, as well as for scattered counties in the western South.

Peak Negro population was attained in 1930 by counties scattered throughout the South, with concentrations only in Oklahoma

and Texas. The censal year 1940 marks the maximum for much of Mississippi, southern Arkansas, Louisiana, and eastern Texas. Apart from North Carolina and peninsular Florida, only counties with urban centers attained their maximum Negro population in 1950.

The pattern of shifting maxima, first south and then west, is closely related to the history of Negro migration: first from the hills, then from the South Atlantic states, and, since 1940, from the trans-Mississippi South.

RICHARD HARTSHORNE—*A Rational and Elementary Classification of Climates*

What are the prerequisites for classification of climates useful in geography? For research studies measuring the correlation of the several climatic variables with other specific variables of area it is necessary to use separately the precise data for temperature and precipitation or to construct types in terms of significance to the specific variables under study. Any one standard system, however complex or detailed, can provide at best an approximation of what can be more precisely measured by using the data directly. A single world system combining the independent climatic elements into single classes is useful only as a general background or framework of world regions, either for the elementary student or for the advanced scholar in geography.

No one system can correspond to the variations of all other significant variables, nor to those of any group of variables in all cultural areas. It can only select those climatic variations that are most commonly of greatest significance to those other geographic variables which are generally most important in total areal variation. At the same time, to serve as a mental background of world geography, it must be sufficiently simple and systematic to permit mental retention.

In large degree vegetation, soil, crop production, living conditions, economic development, and hence total areal variation are determined by differences in temperature and moisture conditions during the period of the year warm enough for crops. Common speech as well as professional usage recognizes five major climatic belts in terms of length of the effective growing season: tropical, subtropical, intermediate, subarctic, and arctic. On the basis of moisture available during the

growing season, we likewise recognize commonly three major classes: humid, semiarid, and arid. To these must be added in the zones of very long growing period two classes in which there is marked contrast between humid and dry seasons. Actual combinations of the two series produce a world pattern of twelve or fewer climatic classes, corresponding closely to common thought and based on a simple system readily understood and retained.

JOHN HILTNER—*The Commercialization of Agriculture in the Turkish Chukurova*

One of the most noticeable changes in Turkey today is the trend from subsistence agriculture to commercial agriculture. Throughout the country farmers who never placed an agricultural product on the market are now marketing wheat, cotton, or vegetables. The purpose of this paper is to investigate the extent and distribution of commercial agriculture in one section of Turkey, the Chukurova, to survey several factors that have favored the development of commercial agriculture there, and to consider possible future developments.

Commercial agriculture took root nearly a century ago among the farmers near the Chukurova's cities. Commercialization later occurred along the railways and much later still along the all-weather roads. The farmers in those areas which were not tapped by all-weather roads or railways remained non-commercial. The number of commercial farmers has expanded rapidly during the past decade. A considerable amount of previously unclaimed land has been consolidated into large land holdings whose owners cultivate cotton and wheat for the commercial market. New and improved transportation facilities have been constructed throughout the area. Farmers with small land holdings have also expanded their production of crops, particularly irrigated fruits and vegetables, for the commercial market.

The marketing aids, price supports, and credit programs of the Turkish government, which remove much of the risk of commercial production, now provide the greatest stimulus to commercial agriculture and promise to do so in the future. Barring major political change, only the discontinuance of these programs is likely to deter the development of commercial agriculture in the Chukurova.

GEORGE W. HOFFMAN—*Regional Integration and Cooperation in Eastern Europe (The Satellite Countries and The Soviet Union)*

Before 1954, economic contacts between the satellite countries of Eastern Europe (Eastern Germany, Poland, Czechoslovakia, Hungary, Rumania, and Bulgaria) and the Soviet Union were largely on a bilateral basis. These contacts tied individual countries closer to the economic and political aims of the Soviet Union, but on the whole contributed little to the integration of the region. The problem of economic cooperation, and especially of regional integration, has received increasing attention since 1954. This is expressed in synchronization of joint plans, a greater exchange of goods, joint financing of important projects of value to the whole region or to the Soviet Union, the establishment of long-term trade agreements, cooperation in technical assistance, and a division of labor for the production and distribution of certain goods. Inasmuch as every one of the satellite countries is dependent on important raw materials from the Soviet Union, and in turn on the markets which will take their finished products, it is essential that these countries know how much the Soviet Union will be able to supply and to buy. In addition, it is necessary to consider the needs of Communist China. This regional integration and cooperation is facilitated through the organization of the "Council for Mutual Economic Assistance." Plans are closely timed to fit in with the plans of the Soviet Union, which is beginning a new Seven-Year Plan that will run to 1965.

These moves toward greater regional cooperation increased Eastern Europe's internal trade and trade with the Soviet Union and Communist China. In 1957 the Soviet Union's share of the total imports by Eastern European countries was 46 percent and that for exports 42 percent. Judging from long-term agreements recently signed, the importance of the Soviet Union in trade with the satellite countries will increase.

LAWRENCE A. HOFFMAN—*Dynamics of Population and Resource Development*

Rapid urbanization and rapid growth are the two main population problems. The development of appropriate institutions and

value systems for an urban-industrial populace are inherently more difficult to achieve than those involved in shifting residence and occupation. Family limitation, desirable in order to gain larger per capita economic rewards from modernization, is less difficult to attain than complete urbanization; similar demographic transitions have been successfully achieved by complex cultures at each major change in civilization.

Quantity, variety, and cost of resources available to modern urban-industrial civilization correlate more closely with dynamic science and technology than with the more passive population and natural-phenomena factors. Prospects indicate a rise in the annual per capita materials consumption while the cost in terms of a share of total income declines. The increased demand for materials comes partly from increased pressure of population but much more from increased pressure of standards (for example, the luxuries of the elite becoming mass comforts and necessities). Most materials shortages reflect problems of timing rather than problems of absolute deficiency.

Prospective natural-resource patterns are no more predictable than those of new knowledge and wisdom: the earth must be constantly resurveyed in the light of changing numbers, changing social and material technology, and changing wants and needs. However, prospects indicate that the net effect of the diffusion of urban-industrial civilization throughout mankind in the next century or two will be great increases in both absolute and per capita resources, although not to the same extent everywhere.

DONALD W. HOGUE—*Temperature Differences on the Greenland Icecap*

Climatic data from 23 temporary icecap stations were surveyed to determine local differences in mean and extreme temperatures on the Greenland Icecap, based on both recent and earlier information. Since the elevation of the Icecap increases rather steadily toward the interior and its surface is relatively homogeneous, the problem of analysis was greatly simplified.

Temperatures diminish with increasing latitude and elevation; the latter appears to be the more important temperature control. A

comparison of stations situated at similar elevations indicated a consistent lowering of monthly temperatures toward the higher latitudes. Storms produce significant and frequent changes in temperature and wind, the two climatic elements probably most indicative of conditions on the Icecap. During May, 1956, at Site 26, the absolute minimum temperature of -66°F. occurred at 1800 hours, and just 24 hours later the absolute maximum for the month, 43°F. , was recorded. When low temperatures for the coldest month are considered in combination with wind speeds, "windchill" (as defined by Siple) in the interior of Greenland is more severe than in any other part of the Northern Hemisphere. Daily temperatures vary as frequently in winter as in summer, but the fluctuations are more severe during the colder season.

Temperature contrasts between higher interior stations and stations in the outer margin are considerable. In the marginal zone, mean temperatures in the high thirties and the low forties are common during the summer months. Mean temperatures in the interior area are usually about 10 to 40 degrees lower than in the outer zone, depending on the season and latitude of the stations considered. An extreme minimum temperature of -87°F. in January at Northice and an extreme maximum of 33°F. in June at Central Station were recorded in the high interior area. In the marginal zone, an extreme minimum temperature of -58°F. occurred at Borg and an extreme maximum of 63°F. at Britannia S ϕ , both in the relatively dry northeast area.

DAVID J. M. HOOSON—*The Middle Volga—An Emerging Focal Region in the Soviet Union*

The spectacular growth of population in Siberia should not eclipse the fact that the bulk of Soviet industry and population still lies west of the Urals. The changing geographical values within European Russia itself are reflected in regional rates of growth, and the spotlight is turning increasingly to the Middle Volga region, centered on Kuibyshev.

Sixty-five years ago, as the railway was beginning to push eastward, the Middle Volga was something of a "frontier," in spite of its established importance as a north-south artery. The left bank was "Siberia," with its absence of communications, economic devel-

opment, and social cohesion. The economy of the region was primarily agricultural, and power resources lay untouched. This condition prevailed essentially until the second World War.

Today's picture represents a transformation. The center of gravity of the Soviet population lies in this region and the rail links with Siberia and Central Asia, as well as the water links with all the Russian seas, Moscow, and the Ukraine make this fact geographically meaningful. The Middle Volga has become the greatest powerhouse of the Soviet Union. Along the river and toward the Urals stretches the oil field that supplies more than two-thirds of the Soviet oil and contains four-fifths of the known reserves—oil being piped to Moscow and Central Siberia. The river itself is virtually a string of lakes, and electricity from the giant Kuibyshev dam is transmitted to Moscow and the Urals. The old Volga towns are experiencing an industrial renaissance and have grown, since the war, more rapidly than those of the Ukraine or the Moscow region.

CHIAO-MIN HSIEH—*Geography in Communist China*

Since the Soviet Union's yesterday is Communist China's today, geography, like other sciences in Communist China, has had to be reoriented to follow the Soviet pattern. The Institute of Geography has been reorganized and has concentrated on two missions, one to compile a regional geography of China and the other to carry out field surveys in compliance with the government's economic development programs under the First Five Year Plan. Four monographs dealing with regional geography have been published, and survey parties have been sent into 25 provinces and have covered about one-fifth of the total area of the country. The chief concern of these surveys has been to advance regional economic development as related to irrigation, soil conservation, navigation, and railroad construction.

Four geographical periodicals are published in Communist China today. The most important is *Ti Li Hsueh Pao* (*Geographical Journal*). It has a circulation of about 3600 and is the chief scientific and theoretical organ of Communist Chinese geographers.

In Communist China five universities, fifteen teachers' colleges, and twenty normal schools have departments of geography. In 1956 there were about 6700 students majoring in geography and the combined faculties numbered about 900. Seventeen Russian geographers have come to Communist China. In accordance with the Soviet concept of geography, there are only two branches—physical geography and economic geography. Physical geography has been emphasized, and economic geography is mainly concerned with regional economic planning within the framework of Marxist-Leninist doctrine.

The purpose of this paper is to report on the current status of geography in Communist China, including the geographical research centers, the geographical journals, and geographical education, and to analyze the content of Chinese geographical publications and their future trends.

ROBERT E. HUKÉ—*Ifugao Rice Terraces*

One of the wonders of the world, the Ifugao rice terraces, is located in the Cordillera Central of northern Luzon. Terraces are scattered throughout the Cordillera but reach their ultimate development in the vicinity of Banaue, on the eastern flank of the mountains. Here terracing often extends over a vertical distance of 2500 feet on each side of the valley and individual steps of 40 feet are not uncommon. Fields have been in continuous use for at least 1500 years and show almost no damage by erosion. This is soil conservation developed to its ultimate.

Rainfall in Ifugao averages 100 inches a year, concentrated in the period May–December. Since two and sometimes three crops of rice are raised each year and since rainfall is sometimes inadequate, carefully constructed canals have been built to carry irrigation water around the mountains.

The area's second crop, and for the poorer people the most important food, is the sweet potato. This crop is grown by the *kaingin* system of shifting cultivation, normally on very steep slopes. Although the system appears to be the antithesis of the soil conserving terraces, the method of cultivation keeps erosion to a minimum.

Terrace-building people probably moved

into Luzon from South China more than 2000 years ago. Terrace culture spread from the Lingayen Gulf along the mountain front. During the early Spanish days terrace cultivators in accessible areas as far south as Laguna de Bay were forcibly moved to the lowlands and have lost their identity. In the less accessible Cordillera Central terrace culture has maintained its distinctive features.

GRAHAM HUMPHRYS—*The "Montferré" Mining Region, Southern Labrador-Ungava*

The Montferré region is underlain by an iron formation thought to be a southward extension of the Labrador Trough. Reserves of iron ore grading 30–35 percent iron are estimated in thousands of millions of tons.

Iron ore was first reported in the area by A. P. Low in the 1890's, stimulating intermittent prospecting which was continued until 1908. In 1951 Quebec Cartier Limited, a subsidiary of the United States Steel Corporation, staked claims near Mount Reed and Mount Wright in northern Saguenay County, Quebec. Their action attracted the attention of other major North American iron and steel companies, many of whom have options or properties in the region today. In 1958 Quebec Cartier awarded contracts for the construction of a new 197-mile railway from the St. Lawrence north to their properties near Mount Reed and for the construction of two new towns, mine and ore concentrating plant, dock facilities, and a power station. Production is aimed at 8 million tons of concentrate per year, starting in 1961. Companies that hold properties in the eastern part of the region hope to move any ore produced via the Quebec North Shore and Labrador Railway to the port of Sept Îles. Recent surveys suggest that it will be possible to ship the ore throughout the year from Sept Îles and Port Cartier to the eastern seaboard of the United States and to Europe.

The recruiting of labor from the Montreal Plain will make the region an outlier of French-speaking, rather than English-speaking, Canada. The Montferré region is only one of six regions of mining activity in Labrador-Ungava which are rapidly bringing the peninsula into Canada's effective national territory.

FREDERICK HUNG—*Notes on the Geographic Study of Population in Monsoon Asia*

Monsoon Asia extends from Japan to the Indian subcontinent. Divided politically into 26 countries and territories, it has one-seventh of the world's land and 53 percent of its population. Within its confines are located two of the world's major population centers—China-Korea-Japan-Vietnam (the East Asian agglomeration), with 770,000,000 persons; and India-Pakistan-Ceylon, with 473,000,000 inhabitants.

With the exception of Japan, the whole area is generally still in the pre-industrial era, living on subsistence agriculture with its characteristic population patterns of compact rural villages, small market towns, old administrative-fortress-residential cities built by the ruling oligarchy in the past, and the ostentatious trading-port cities established by European colonial administrators and business houses.

Overpopulation is a grave problem in the area, but contrary to a myth propagated by textbooks and newspapers, Japan is actually the least overpopulated country in Asia; it has the highest living standard outside the Western world, and is enjoying a period of prosperity unprecedented in its history. With economic development comparable in per capita terms to that of Japan, India and China should be able to support a population twice the present size, although the peoples concerned would be far better off with a stabilized population.

Good population maps on an intermediate scale (1:500,000 to 1:1,000,000) are available only for limited areas such as Japan. The 1953 census of China has not yet been mapped.

HENRY L. HUNKER—*Ashtabula: A Study of Location Factors in the Chemical Industry*

The United States chemical industry has undergone dramatic change in its productive capacity and regional orientation since World War II. The older producing states of the Middle Atlantic and Middle West continue to dominate the industry but outstanding growth has occurred in the Gulf South and California. Ohio's position deteriorated relatively from 1945 until 1955. Currently the state ranks fifth in net value, accounting for approximately six percent of the national total, but in

dollar expansion since 1955 Ohio ranks third. Ashtabula, Ohio, reflects much of the vitality of the national chemical industry. A representative product of the postwar period, the city provides an excellent setting for the study of the several factors that affect the localization of chemical plants.

The present chemical industry is an outgrowth of a federally-sponsored ferro-alloys plant built in 1943. The federal government, as the dominant factor in the location of this plant, recognized in the nearby steel industry a market for ferro-alloys, the accessibility of raw materials through the lake port, and abundant electric power in the area. Subsequent chemical firms have recognized these advantages as well, but the impelling force in their location has been inter-plant linkage. Through pipelines established between plants, basic raw materials and/or finished chemicals are exchanged. An ever larger complex of chemicals emerges from the area.

This paper considers the changing role of government as a factor in the development of the chemical industry in Ashtabula; it appraises the role of the other location factors that have been responsible for the continuing expansion of industry in the area; and it stresses the significance of linkage as a force in the localization of the chemical group.

JAMES M. HUNTER—*Parallel Ideas of Ratzel and Hartshorne in the Methodology of Political Geography*

This paper is a comparative study of the methods in political geography that are suggested in Friedrich Ratzel's "The Laws of the Territorial Growth of States" and in Richard Hartshorne's "Functional Approach in Political Geography."

The Ratzel method receives little attention, since it is known that some leaders in political geography have classified it as "dangerous and pseudo-scientific." The result is stated by Broek: "Many of his fruitful ideas are ignored or ascribed to other writers." The Hartshorne method, in contrast, is accepted by most political geographers as an acceptable scientific method.

Therefore, the major purpose of this paper on the comparative study of these two methods is to identify precisely the parallel ideas that exist in them. Further, it concludes that

the two methods, for the most part, are in reality not different; that the functional approach represents a modern state territorial development method as it has evolved over a time-tested period; that each geographer started with the same viewpoint in political geography and utilized the same basic ideas in his study. Therefore, since the functional approach is accepted as scientific, it must follow that the Ratzel method must also be accepted as scientific. Today this condition represents a degree of standardization of method that heretofore was lacking and was a handicap in the field of political geography.

The minor purpose of the paper is to encourage the use of both methods, one to augment the other, especially in applied political geography.

FRANK C. INNES—*Colonization in the Quebec Clay Belts*

Today there is some stagnation in agricultural pioneering to the north of the world's settled areas, at least in the free world. However, this pause in the general movement would appear to be temporary, and it affords an opportunity for reassessing such pioneer movements, and for suggesting the lessons that can be learned from those of the past.

In this connection, a detailed study has been inaugurated in northwestern Quebec. This is one of the more recently active areas of colonization, and one in which there has been a fair measure of control and planning. This paper has been prepared to lead to a discussion of some of the findings to date.

First, a terrain map based on aerial interpretation is compared with a map of the present major land uses; then some explanation of the relationships between these two is sought in a presentation of a series of maps illustrating the colonization of the area decennially over the past 80 years. Together with these map studies, something of an understanding of the motives and reasons for settlement in the area are outlined, from which it is argued that the more recent government-organized settlement has owed almost as much to idealist leaders as to economic conditions. In fact, this emphasizes the idea of Professor Crowe of Manchester that geographers should not be so concerned with men in the mass as to neglect those whom he calls "effective."

The study provides background material for those who may wish to plan pioneer settlements in the future, and also provides a case study on an idea that the author thinks is useful methodologically in a study of human geographic problems.

PRESTON E. JAMES—*Concepts Derived from the Study of World Geography in the Secondary Schools*

When world geography is presented with historical perspective, as historical geography, it develops the following chief concepts or understandings:

(1) The world pattern of "habitats," and the significance of these major physical and biotic divisions;

(2) The areal relation of the pattern of people to the pattern of groups of natural regions;

(3) The world major culture areas, defined in terms of the impact of the two great revolutions—the Industrial Revolution and the Democratic Revolution—on the pre-existing cultures, provide the most effective framework for a true blending of the dimensions of geography and history.

GEORGE F. JENKS—*Selection of Area Shading Patterns for Maps*

One of the most common deficiencies of published maps is the poor selection of shading patterns by the map-makers. This paper attempts to bring some organization to the selection and use of commercially available shading patterns by answering the following questions:

(1) What shading patterns are safest to use with a wide range of reproduction methods and with varying degrees of reduction?

(2) What styles and textures of patterns are preferred by most map-users?

(3) How can a series of quantitative area shading patterns, which give good tonal gradations, be selected from the great number of shadings that are commercially available?

A series of 24 plates was prepared to test map-user preferences for pattern, value, and texture of area shadings. These plates varied in the number of patterns per map, in the style and texture of pattern, in the scale of reproduction, and in the combinations of patterns having different value series. Four

questions were asked on each plate in the test and the results presented here are based on the responses of 129 persons with varying degrees of map experience. A second part of the research consisted of testing 274 different patterns for reproducibility at full scale, at 2/3 scale and at 1/3 scale.

Map users prefer area shadings of fine texture, and fine texture appears to be closely related to the map-reader's sense of accuracy. Dot patterns are considered to be more pleasing and more accurate for area shadings than other styles. Irregular patterns are least liked and are felt to be least related to accuracy. The test results substantiate Williams' work and the use of his "Curve of the Gray Spectrum" will result in a selection of shading patterns which are considered to be most accurate by 68 percent of the map users. Preferences for style and texture of pattern and the map reader's sense of accuracy do not appear to vary with map experience nor do they seem to vary for maps reproduced at different scales. Figures and tables are presented to facilitate use of the findings by cartographers.

J. GRANVILLE JENSEN — *Mexico, World Competitor in Frasch Sulfur*

Mexican Frasch sulfur production, unimportant before 1955, has soared to an output of more than one million tons annually, placing Mexico in the ranks of major suppliers of sulfur and significantly modifying the pattern of world sulfur trade and competition.

This paper reports the development as investigated in the field in November, 1957. The appraisal is organized under three main headings: (1) analysis of governmental relationships with the private companies, together with maps showing land concessions and known resources; (2) commentary on major developments such as housing, production facilities, and impact on the local economy; and (3) summary of production and the pattern of export competition, chiefly with the United States export. The paper is illustrated with diagrams, maps, and photographs of the development at the Jaltipan dome.

ARTHUR E. JORGENSEN—*Preliminary Investigation of Mean Temperature at the Amundsen-Scott IGY South Pole Station*

During the International Geophysical Year, 1957-58, an initial investigation was made of the mean surface temperature at the South Pole and the factors affecting it.

In considering the mean, an interesting observation reveals twice as many months with average temperatures below the mean annual temperature as there are months with averages above the mean. This is assumed to be due to the proportionality of the rise and fall of the temperature to the elevation of the sun during its presence and is revealed by comparing the temperature trace with a trace representing incoming radiation during the same period of sun.

In contrast to the relative warmth and consistency of the temperature during the summer months, the winter or dark period is characterized by colder temperatures, to be sure, but with greater fluctuation in an overall observation. The lack of solar radiation is, of course, the major reason for the general decrease in temperature; however, the many fluctuations in the "daily march of temperature" during this period are the result of various local effects. An attempt to explain some of these phenomena is the main objective of this investigation.

Among the local factors is the mixing by the wind of surface air with warm air from aloft, which is clearly shown by traces of inversions taken from upper-air balloon soundings. Another important factor is observed by inspecting the data that exist concerning the topography of the plateau and by comparing South Pole meteorological data with those of Sovietskaya; a katabatic drainage effect is brought to light whenever the temperature dips below -100°F . Also, as in most other places throughout the world, re-radiation from cloud coverage contributes greatly to the raising and lowering of the temperature trace.

It is worth while to discuss the comparison of the surface annual mean temperature with temperature readings obtained from holes drilled at various depths in the "snow mine." This may be evidence of a warming climate in the Antarctic regions.

In conclusion, stress must be placed on the

fact that information contained herein was obtained from a relatively short record. However, some significance can be claimed on noting the eternally uniform character of the South Polar Plateau.

PRADYUMNA P. KARAN—*The Pattern of Land Utilization and Possible Expansion of Cultivated Area in Nepal*

A land-use map of Nepal compiled from aerial photographs taken in 1957 is used to analyze the pattern of land utilization. The geographical distribution of cultivated areas, the forests and pastures, and the waste lands are examined to assess the possibilities of securing more intensive use of the land resources.

The land-use pattern in Nepal, like that in most other countries, has been conditioned by (1) the physical factors that set limits upon the capabilities of land, and (2) the human factors, such as the length of occupation, density of population, social and economic institutions, and technological resources of the Nepalese people, that determine the extent to which the physical capabilities of land are utilized.

Nepal's land use, in which cultivation is more intensive than grazing or forestry, comes closer to the physical capabilities of the land. The scope for the expansion of cultivation is limited by many physical factors—for example, the deficiency of moisture and prevalence of malaria—most of which can be corrected only by expensive modern methods beyond the limited resources and simple techniques of the Nepalese farmer. Cultivation can be extended in some areas through deforestation. But there are larger areas of cultivated land which should be reforested as a measure against soil erosion and flood. It follows that any significant increase in agricultural production to meet the ever-increasing needs of Nepal's growing population must come through larger yields from lands already under cultivation rather than through an increase in the cultivated area.

GERALD J. KARASKA—*The Basic-Nonbasic Concept Applied to an Anthracite Mining Community*

The basic-nonbasic concept of economic functions is important in identifying the "critical" industries and functions in an urban com-

munity. "Critical" refers to the relation of the basic components of the economy to the service functions, i.e., an absolute increase or decrease in the basic industries brings about a subsequent adjustment of the nonbasic components, and an eventual change in numbers of the total population of the community.

The basic-nonbasic concept provides a useful means of portraying the critical functions of the changing economic structure of Wilkes-Barre, Pennsylvania. In 1924 mining employed 46,000 basic employees, whereas by 1954 this figure had fallen to 11,000. The decline in importance of this critical industry has created a severe unemployment problem that has been a factor in emigration from the area and has occasioned an adjustment in the character of the base itself. In the resulting shift manufacturing now constitutes a more significant basic sector of the economic structure of the city.

In the identification of the economic base of Wilkes-Barre, a simplified interview approach was used. Sample firms in each of the major activities of the city were interviewed. Responsible management personnel of these firms were requested to give an estimate of the percentage of their sales outside the Wilkes-Barre Urbanized Area. The results of the interviews were then used to distinguish the basic and nonbasic activities of the city.

HENRY MADISON KENDALL—*Agricultural Patterns in Pennsylvania*

The broader patterns of agricultural change in Pennsylvania are indicated on crop combination maps for 1949 and 1954. The dominant combination in both years was the four-crop combination, hay-oats-corn-wheat. This combination occurred in 44 of the state's 67 counties in 1949; in 43 of the 67 in 1954. Five other combinations were present in 1949; in decreasing order of importance, they were corn-hay-wheat, hay, hay-corn-oats, hay-corn-barley-wheat, and hay-oats. In 1954, seven other combinations were present: hay-corn-oats, hay-corn-wheat, hay, hay-corn-oats-wheat-barley, hay-corn, hay-corn-oats-wheat-soybeans, and hay-corn-wheat-barley-soybeans.

Changes occurred in eleven counties. Of these, five are the relatively highly urbanized

southeastern counties, five are scattered across the Allegheny Plateau, and one is in the Ridge and Valley region. In the southeastern and Ridge and Valley counties, change resulted from increased harvested acreage in either soybeans or barley and decreased acreage in wheat. Through the Plateau, change resulted from decreased acreage of hay.

Greater diversification in terms of the relative importance of individual crops is part of continuing agricultural change over the past 35 years. Certain other measures are the decrease in land in farms (25%), the decrease in cropland harvested (31%), and the decrease in total land in pasture (20%). In contrast, intensification is evidenced by the fact that the number of milk cows decreased by only one percent during the same period.

LORRIN KENAMER, JR.—*Irrigation Patterns in Texas*

Expansion of irrigation in the postwar years has advanced irrigation farming to a significant place in Texas agriculture. This expansion was from about one million acres under irrigation in 1940 to approximately seven million acres by 1956. In the drought year of 1956 it is estimated that the seven million irrigated acres, representing about one-third of the crop land harvested in the state that year, produced about two-thirds of the state's income from harvested crops.

About six million acres of the state's irrigated area are supplied from ground water. A substantial portion of this ground water, particularly in the semiarid parts of the state, is obtained from storage that is being progressively depleted. The acreage irrigated from surface water is found mainly in the southern and southeastern parts of the state. More than 50 percent of this acreage is in the Lower Rio Grande Valley; most of the remainder is in the Gulf Coast area.

The purpose of this paper is to examine the distribution of irrigated acreage, both by region and by type, and to present trends and problems in this rapid expansion of irrigated agriculture. The following questions are touched upon: (1) What is the present extent of irrigation development? (2) What are the relationships between irrigation areas and types of water supply? (3) What crop patterns are found in the irrigated regions? (4)

Which irrigated regions can be visualized as a permanent part of agricultural production in the state? (5) What role has resource management had in irrigation development in the state?

YING-CHENG KIANG—*The Chinese Garment Industry in San Francisco*

The Chinese garment industry in San Francisco started after 1848. By 1958, San Francisco had 132 Chinese clothing factories, which employed 25 percent of all the garment workers in the city, and provided a payroll that amounted to 30 percent of all the wages from San Francisco's Chinatown, the biggest Chinese community in the United States.

Of the 132 Chinese factories, 16 are "inside shops" and 116 are "sweatshops." The inside shops, with an average of 24 workers each (mostly Chinese women), purchase, cut, sew, and finish the denim goods for marketing. The sweatshops, with an average of 17 workers each, just sew and finish the garments for the major clothing manufacturers or jobbers in San Francisco.

The factories are concentrated in Chinatown. Many of them use abandoned retail stores, garages, and basements for which the rent is low. The shops are near the workers' homes. This fact, together with a flexible working schedule, enables some Chinese women to work in the factories, and also care for their children. However, seven sweatshops are located in residential zones, and 14 inside shops and 104 sweatshops are located in commercial zones. Most of these factories violate the existing city zoning ordinance, adopted in 1921. In 1958, an amendment was made to create a designated area in the commercial part of Chinatown for the purpose of recognizing some, but not all, of the "unlawful" sites of the Chinese garment factories. However, the final solution lies in the evaluation of the 1921 city zoning ordinance, and its 1958 modification.

LESTER E. KLIMM—*Some Patterns on the Pennsylvania Landscape*

The classic regionalization of Pennsylvania has been physiographic, emphasized by the dramatic patterns which Appalachian structure gives to its landforms. As in most areas that geographers study, the basic "topograph-

ic" map was, for a long time, one of the few maps of large areas in which form and pattern appear as the result of instrumental survey. The result has been a tendency—perhaps unconscious rather than otherwise—to make the boundaries of other distributions (usually known only imperfectly) conform to physiographic boundaries because of stated or tacitly assumed causal relations.

A map of land use in Pennsylvania at a scale of 1:250,000 has been constructed at the University of Pennsylvania from aerial photography. The land use chosen for comparison with other distributions here is cropland. Comparison is then made, notably with elevation, classical physiographic regionalization, surface temperature, and roads. As would be expected, the apparent effect of the landforms on other distributions is strong. However, the cropland map and others show patterns—particularly on the "Appalachian Plateau"—that emphasize diversity.

Any such close examination of detailed distributions emphasizes the caution that, in the Northeast in general and in Pennsylvania in particular, the diversity is so great that concept of a "statistical" or "high potential" unity for the "Northeast" needs to be complemented with study of actual distributions of economic and other phenomena at the largest possible scale.

HUEY LOUIS KOSTANICK—*Population Patterns in Poland*

As a result of World War II, Poland suffered drastic territorial changes, which, in effect, moved the country westward in Europe. Associated with these territorial changes were major population shifts, both into and out of Poland, that created greater ethnic homogeneity.

The cession of Eastern Poland to the Soviet Union involved transfer of Poles who did not elect to remain as Soviet citizens, although some chose to stay in the Soviet Union.

The annexation of German territories and of the internationalized area of Danzig created essentially a "colonial" situation, in that the exodus of Germans from these regions provided new lands for settlement and use. These new lands have become "frontier" territories; they have served to resettle Poles from the lost territories, have helped absorb

some of the rural overpopulation, and have also become national "buffer zones" against Germany.

The greatest migrations have been to industrial districts in former German Silesia and to the farm lands of former East Germany, but only limited success has been achieved in Polish East Prussia.

The problems of settlement are complicated by the legal situation. Lands lost to the Soviet Union were legally ceded by treaty but the lands annexed from Germany are only under "occupation and administration" by Poland until such a time as a German peace treaty is signed.

ANTONI KUKLINSKI—*Polish Industrial Geography: Some Problems of Research*

In this paper four approaches in Polish industrial geography are distinguished—systematic, regional, topical, and cartographic. The *principium divisionis* of this classification is the starting point of a given investigation. Hence, the systematic approach is used when the starting point of the research is a branch of industry; the regional approach when it is an industrial district; the topical approach when it is a case of a topic concerning more than one branch of industry and more than one industrial district; and the cartographic approach when the main object is the preparation of maps and atlases.

1. *Systematic approach.* The most advanced studies in Poland concern the geography of building materials, and of the textile and food industries. Briefly, the problems involved in the investigation of the brick and cement industry are reported. These problems comprise: (1) changes in the spatial pattern of the brick and cement industries in Polish territories during the last 100 years; (2) spatial differentiation of costs of production in the brick industry (based on a questionnaire for the year 1955); and (3) the influence of the natural environment on the size and location of selected plants in the brick and cement industry.

2. *Regional approach.* At present four industrial districts are being investigated by Polish geographers—the Upper Silesian and the Lower Silesian Industrial Districts and the Industrial Districts of Lodz and Warsaw. Some problems involved in the investigations

of the Industrial District of Warsaw are presented, as follows: (1) analysis of the historical development of the district during the last 100 years; (2) detailed analysis of the present spatial pattern of this district; and (3) detailed analysis of the spatial relationships between selected branches of industry in this district.

3. *Topical approach.* This is the most recent type of Polish research. The object of the first study, started in 1958, is the evaluation of the effects of the industrial locational policy carried on in Poland during the Six Year Plan (1949-55).

4. *Cartographic approach.* In 1957 the Institute of Geography of the Polish Academy of Sciences, with the collaboration of the Central Statistical Office and the Planning Commission of the Council of Ministers, began preparation of a large industrial atlas of Poland. The atlas will provide: (1) a synthesis of the present knowledge about the spatial structure of industry in Poland; and (2) a starting point for discussions and studies concerning the locational changes in Polish industry in the time from 1960 to 1975.

EARL E. LACKEY—*A Nomographic Method of Assessing Hourly Temperature Frequencies from Limited Weather Records*

Hourly temperature frequencies for any desired percentage of the time may be determined by use of a nomograph when only the mean monthly temperature, the extreme minimum, and the extreme maximum are available.

The nomograph was constructed from hourly temperature records secured from 10 widely separated stations in middle latitudes. In order to prepare it, each record had to be converted to a percentile scale. From these converted values, the nomograph was devised. The performance of the nomograph was validated by the use of corresponding hourly records from 40 stations in the eastern and western hemispheres, scattered from Bangalore, India ($12^{\circ} 57' N.$), to Clyde River, Baffin Island ($70^{\circ} 25' N.$).

By use of the nomograph and the three temperature values (mean, extreme minimum, and extreme maximum) anyone can easily determine approximately (1) the temperature that may be expected for any given percent-

age of the time, or (2) the expected percentage frequency that any given temperature may occur. By entering the converted values of the nomograph onto punch cards, the whole task may be accomplished rapidly and accurately on an IBM 604 calculator by machine processing.

JAMES P. LATHAM—*Measuring Characteristics of Distribution in Pennsylvania Cropland Regions*

Areal phenomena are often so complexly distributed within a region that it is impossible to isolate the dispersants into units, and hence difficult to determine and describe the size, shape, and orientation of the occurrences.

Some characteristics of cropland and non-cropland distribution within Pennsylvania regions are sampled by evenly spaced, parallel traverses, and the intercepts with each dispersant are organized into an array or frequency-like table of distance classes. The median and quartile values of the uninterrupted distances (intercepts) are determined for each surface type. They provide a quantitative basis for describing the distribution verbally, by means of statistical curves, and by graphic symbolization. These values indicate aspects of the "average" journey that crosses the regions in the directions sampled. They make it feasible to describe the journey in terms of: (1) proportion of journey on each type of surface; and (2) percentage of passages across a surface type that will fall within given minimum and maximum length classes.

When the parallel traverses are rotated to sample six azimuths 30° apart, the comparison of median and quartile values for these azimuths indicates the orientation of the dispersant (cropland). These values and orientation influence can be represented in a graphic symbol termed "the orientation rose." From the data secured from the rotated parallel traverses, it is also possible to estimate for each region: (1) total area and (2) proportion of total area occupied by each dispersant.

GEORGE K. LEWIS—*Changes in Suburban Land-use Patterns*

Changes in the land-use pattern of the rural-urban fringe of our metropolitan cities are being closely watched by planners, geog-

raphers, and others. Certain trends are discernible in the occupance of open land by residential, commercial, industrial, and other uses associated with urbanization.

Details are given for an area on Metropolitan Boston's outer fringe (Wayland, Mass.) that represents some of these trends, and relationships between the new types of land use and the parts of the landscape that each supercedes are pointed out. This area is undergoing rapid suburbanization.

A second area nearby (Concord, Mass.) is described; this area was studied and mapped in detail by Ackerman in 1940, prior to intense suburban development. Here, some of the trends cited in the first example are not following the same pattern, particularly in regard to changes in agricultural land. Reasons for this are sought in recent social and economic developments. Ackerman's tentative predictions of the (sub)sequent occupance of Concord are examined in the light of the present.

These two examples illustrate, in part, the role of the geographer in the planning process—a role which can and should make an increasing contribution as our metropolises continue their rapid and often chaotic expansion.

PEIRCE F. LEWIS—*A Cartographic Analysis of Voting Behavior*

Politics differ from place to place, and the differences can be shown on maps of election returns. Political attitudes, however, are related to certain population characteristics, which are also mappable. A comparison of maps, therefore, should reveal characteristics of group voting, and the present study is designed to test how effectively such comparisons can be made. Such a test is desirable because students of American voting behavior have often used maps as illustrations or as means of recording data, but seldom as analytic tools.

Flint, Michigan, was chosen as a testing ground for cartographic analysis of voting behavior. Maps of selected election returns were compared with economic and racial maps, and overlays were drawn to make the comparisons more explicit.

The maps revealed four major elements of group voting in Flint between 1928 and 1956:

(1) The present pattern of party loyalties

evolved and became established during the New Deal, and has changed only in detail since that time.

(2) The relationship between income and party voting is strong, with high-income areas voting heavily Republican, and low-income areas heavily Democratic. This relationship only became pronounced early in the Depression, but has remained so ever since.

(3) Flint's Negroes were largely Republican until 1932, but had become the mainstay of Democratic strength by 1950. Poorer Negro areas began voting heavily Democratic in the mid-1930's, but those of higher income could not be counted "safely" Democratic until 1948.

(4) In voting for nonpartisan issues, economic and racial factors are much less significant than in partisan voting.

DAVID LOWENTHAL—*Population Contrasts in the Three Guianas*

Extraordinarily uniform from the Amazon to the Orinoco, the Guiana coastal plain shares a history and supports a present-day population unique on the continent. Neither "Latin" nor "American," the 800,000 inhabitants of British, Dutch, and French Guiana—all but a handful of them along the coast—are chiefly north European in nationality, Asian and African in ethnic origin, and Hindu, Protestant, and Mohammedan in religion.

Alike plural and exotic societies, in which dominance is shifting from white creoles and Europeans to descendants of slaves and indentured laborers, these three relics of great imperial systems are none the less remarkably dissimilar. This paper describes some of the differences and attempts to answer such questions as the following: Why is French Guiana agriculturally undeveloped and for the most part uninhabited, while Surinam and British Guiana have ten and twenty times her population and—despite overcrowding—twice her rate of growth? Why is settlement in British Guiana stretched like a ribbon along the coast, while people in Surinam cling to river-bank locations? Why do Negroes, East Indians, Chinese, Portuguese, and even British speak a common language and live together in the villages of British Guiana, while their counterparts in Surinam retain separate tongues and dwell in isolated communities? Why is life for

the people of British Guiana (a colony) less "colonial" in most ways than for the inhabitants of Surinam (a self-governing realm) and of French Guiana (a *département*)?

PAUL E. LYDOLPH AND THEODORE SHABAD—*Soviet Oil and Gas: Recent Exploitation and Utilization*

A reversal in governmental policy has brought about a revolutionary change in the oil and natural gas industry of the Soviet Union in the last few years. The trend is confirmed by the Seven-Year Plan (1959-1965).

Coal, long the major source of Soviet fuel requirements, is being rapidly displaced by oil; in 1955, oil and gas supplied 24 percent of all fuels, compared with 65 percent supplied by coal. By 1965, oil and gas are expected to account for 51 percent and coal for 43 percent. This shift in emphasis is accompanied by a rapid rise in the production of oil (from 71 million tons in 1955 to 230-240 million in 1965) and especially of natural gas (from 9 billion cubic meters in 1955 to 150 billion in 1965).

Such a proposed expansion of output is prompted by the need to conserve capital and labor in the fuel industries, to relieve the load on the railroads, and to provide a firm basis for a greatly expanded petrochemical and plastics industry. The expansion is made feasible by a fivefold increase in proven oil reserves, accompanied by a radical shift in geographical distribution from Baku to the Volga-Urals area. Other contributory factors are the growth of the steel industry for the manufacture of oil and gas pipe, and the increase in skilled technicians for the oil and gas industry.

The paper summarizes changes in production and consumption patterns, and assesses the effect of the Soviet oil and gas boom on further industrial build-up.

VINCENT H. MALMSTRÖM—*The American Impact on Iceland: A Geographic Appraisal*

Through most of her history Iceland has been an isolated outpost of civilization. Since the dawn of the Air Age, however, she has been thrust, willingly or unwillingly, into the arena of world power politics. Thus, from 1941 to the present, apart from a short interlude, Iceland has been host to an American

military contingent stationed at Keflavik Airport in the far southwest of the country. The presence of this American installation has had far-reaching economic, social, and political repercussions within Iceland, and it is the purpose of this paper to examine some of these from a geographic viewpoint.

Among the aspects discussed are shifts in population and per capita income, the effects on Iceland's basic occupations and on her foreign trade balance, and the political manifestations that these developments have engendered.

The author concludes that, although Iceland's strategic position will not be altered until further advances in the technology of weapons make a "forward base" less necessary, the country's basic economic and political patterns have been irrevocably changed by the presence of the American air base during the past decade and a half.

GEOFFREY JOHN MARTIN—*An Enumeration of the Natural Problems Attendant on Any Reclamatory Scheme for the Florida Everglades*

For 19 million years following the Miocene epoch, Nature's balance remained undisturbed in southern Florida. Then came the railroad, plumage lust, land hunger, and the dream of an Everglades economic empire. Nature's balance was rudely violated with twentieth century reclamation schemes.

Today, having observed multiple flood disasters, witnessed severe fire consumption of peat and muck soils, experienced salt water intrusion into Florida's "Gold Coast," and watched the very soil deteriorate and disappear both quantitatively and qualitatively, the complacent pioneer of yesterday's last American frontier has awakened.

A multipurpose project approach replaces the single-purpose drainage scheme; capital investment as a flow over time ousts previous irregularly allotted budgetary proposals; federal, state, and local encouragement is lent to data-compiling research groups and organizations. Floridians now realize that the Everglades region does not constitute the economic empire of which Governor Broward dreamed in 1905, a realization bought of the expensive product, experience.

The emphasis, significance, and interest of

this paper to the geographer lies in a detailed and accurate enumeration of the contemporary physical problems confronting the would-be Everglades reclaimer—soil subsidence, water surplus and deficiency encouraged by erratic climatic fluctuation, salt water intrusion, and works-construction difficulties—together with a résumé of geological structure.

SISTER MARY URSULA—*Changing Patterns of Catholic Population in Eastern United States*

A study of the distribution and shift in the centers of Catholic population in eastern United States utilizes a series of choropleth and relative-change maps to show relationships at various periods between 1790 and 1950.

From the early shore and river locations, Catholics moved inland with the advent of post roads, public works, canal and railroad building, and the opening up of other economic activities, such as farming, quarrying, lumbering, mining, and manufacturing. Especially notable was the advance of the Irish along the lines of early canals and railroads, for which they became the chief source of labor. Social as well as physical and economic factors influenced Catholic settlement. Among these were national loyalty, family ties, and love of their religion.

This graphic study of Catholic population in relation to total population reveals a steady northward movement from St. Marys County, Md., in 1790. A century later the relative center had shifted to New England, where it still lies. A parallel portrayal of major immigration sources shows a definite relationship between these two areas of human geography.

Judging from the proportion of Catholics found in eastern metropolitan areas in 1950, at least 85 percent are urban dwellers. Catholic population has increased at a rate faster than the total population, but the difference in rates is decreasing. All observable data lead to the conclusion that present-day transportation, diffusion of industry, and suburban living will probably result in a further dispersion of Catholic population.

NEIL M. MCARTHUR—*A Community Service Approach in Land-use Analysis*

The talents of senior undergraduate and graduate students of geography may be used

to the mutual advantage of the students themselves, the community, and the university when coordinated land-use programs of a community service nature are offered. It does not particularly matter whether the university is located in the midst of a large metropolitan area or in a small college town. The magnitude of the program can be adjusted to fit the needs of the community and the resources of the class. Such a program obviously must represent a convenient balance between formal classroom instruction and actual field work, and must be adequately supervised by faculty members and by the appropriate community agencies.

Without presuming to be community planners, geographers may perform several of the necessary operations of the planning process. In a community service program the work is done by students who benefit by the fact that they are doing actual field projects rather than mere academic exercises. The university benefits from the public relations that are established by a successful program of public service. The communities benefit in that they have projects done for them which they might otherwise not have had. With a proper liaison the extra expenses of such a program may be borne by the communities or by private agencies within the communities, which in turn expands the scope of the projects that the universities may undertake.

CHARLES B. MCINTOSH—*Side-Tracked Villages in East Central Illinois*

The gradual wasting away of small villages located along highways is evident to all who travel the highways. Less often observed is the small village, spawned along a railroad, which has now been by-passed by a highway constructed parallel to, and a short distance from, the railroad. A study of 73 of these villages and hamlets, now "side-tracked" from the main servicing thoroughfare, portrays a retrogression unchecked by the development of filling stations, cafes, and other roadside catering establishments that provide a semblance of stabilization in the decline of villages located on highways.

Most of the cultural features evidence decline. Ten percent of the houses are relict or unpainted and as many as 20 percent of the houses in a village are empty. Only half the

villages now have stores; several stores have closed recently and others will soon close. Grain elevators still represent one of the important economic activities, but many have been dismantled and others have discontinued service. Cultural features, such as the school, post office, and polling place, all evidence adjustments to the general decline of the villages.

Detailed studies concerned with source of resident income reveal that pension incomes are more common than incomes from farms or farm-oriented businesses. The largest number of village inhabitants with earned income work in nearby towns or cities. The primary role of these villages has changed from one of farm servicing to one of providing low-cost rural housing for pensioners and for laborers in nearby cities.

TOM MCKNIGHT—*Wild Horses in Western Anglo-America*

An interesting chapter in the story of American wildlife is that dealing with the "wild" horse. First brought to the shores of this continent as domestic stock by Spanish explorers, horses frequently broke loose from confinement or were turned out on the range, thus beginning a feral existence. As settlement spread westward across the United States and Canada, unowned horses appeared in a variety of localities from the Rio Grande to the Peace River country. Alternately valuable and valueless as the demand for work horses, cavalry mounts, and cow ponies fluctuated, wild horses were subjected to periods of intensive round-ups followed by months or years of relative disinterest. The last decade and a half has seen exhaustive attempts to corral the remnants of the once-vast wild horse herds in order to clear the range for more valuable domestic animals. As a result, the feral horses that are left have been forced into the most remote back country. Nevertheless, the wild horse is not extinct, nor does extirpation seem near at hand. Data collected by personal interview and mail questionnaire from more than 900 individuals familiar with the western rangelands indicate that 20,000 to 30,000 feral horses still inhabit parts of thirteen states and two provinces. As these animals sometimes cause significant range problems, they are objects of considerable controversy

in much of the West, particularly in Nevada. Management plans are haphazard, and a continued slow decrease in numbers may be expected, though extermination is unlikely.

ROBERT B. MCNEE—*Centrifugal-Centripetal Forces in International Petroleum Company Regions*

This study is an application of Hartshorne's centrifugal-centripetal analysis to the interpretation of international company regions. Standard Oil(N.J.) is used as a case study. The approach clarifies significant aspects of the economic geography of petroleum not evident from other types of geographic analysis.

An international company region is influenced by the same centrifugal forces—for example, distance—that affect a national state. In addition, nationalism is a major centrifugal force for international company regions, though it is often a centripetal force within territorial states. Company "team spirit," analogous to nationalism, is less important, probably, as a centripetal force than are legal ownership, economies of scale, functional integration, and centralized research.

Standard Oil(N.J.) supplies about 16 percent of the free world's petroleum; a single affiliate, Creole Petroleum Corporation, produces more oil than the Soviet Union. More than two-thirds of Jersey's production and refining are outside the United States. The corporate regional structure is a delicately balanced federal system, an adaptation to centrifugal-centripetal forces. Zonal firms are most influenced by centrifugal forces; global firms and central headquarters provide the centripetal force to maintain global unity and coherence. Jersey is vulnerable to nationalistic pressures because of the current geographic concentrations of crude production and reserves. Refineries are subject to similar pressures, especially when located in producing or marketing areas rather than in transport nodes. Jersey cannot avoid nationalistic centrifugal forces; it can only hope to maintain the present delicate balance of centrifugal-centripetal forces within its region.

MARY MEGEE—*The Extent of Influence of Monterrey, Mexico*

Monterrey is a national and international supplier of a variety of products. Within

Mexico, Monterrey's relations are primarily of a linear nature along major transportation lines with large Mexican cities, many of which are several hundreds of miles distant. In most cases Monterrey has few relations with the scores of little settlements intermediate between it and the large distant cities. The physical character of the country further restricts its extent of influence. Moreover, many of Monterrey's relations are with the United States. Which are the large Mexican cities with which Monterrey has relations? Do the extents of retailing and manufacturing differ? What criteria may be used to delimit these extents?

Newspaper subscriptions suggest that retailing in Monterrey (1) is overwhelmingly for Monterrey itself; (2) probably does not extend more than 60 miles in any direction; (3) is restricted by the international boundary. Moreover, subscriptions suggest a pattern of migration in Mexico and in the United States.

The distribution of long distance telephone calls and freight flows indicate: (1) that Monterrey is a specialized city with functions of national and international importance; (2) that the cities with which Monterrey has appreciable relations are generally not south of the capital or west of Torreón and Durango; the border cities from Juárez to Matamoros form a northern limit, and Tampico is the southeastern limit; and (3) that between 1940 and 1956 there was an increase in the amount of goods carried between Monterrey and major stations on all railroad lines except the Monterrey-Tampico line. The largest amounts are carried between Monterrey and Torreón.

ALEXANDER MELAMID—*Partitioning Cyprus*

About 80 percent of the population of Cyprus are Greeks; 18 percent are Turks. The two national groups are nearly uniformly distributed over the island, and only very small isolated areas contain Turkish majorities. At present, the Greeks demand union with Greece, and the Turks insist either on maintaining the status quo, with Cyprus remaining a British colony, or on partitioning the island between Greece and Turkey. The various proposals for partition are, therefore, examined with reference to the existing distri-

bution of national groups, physical features, and economic factors. Among the latter, distribution of water supplies, minerals, and harbors has to be considered. Although relatively good physical boundaries can be drawn in support of the various claims, these do not make sense in relation to the existing distribution of populations and economic activities.

ALFRED H. MEYER AND ELMER B. HESS—*Gary Manufactural Design and Destiny*

Gary is world-famous as a "steel city." But knowledge of its manufactural functions is largely limited to its steel-fabricating plants. The manufacturing pattern is here explored in its total environmental setting as an industrial community, including both industries symbiotically related to steel manufacturing and industries not so organically related. Some two-score plants have been interviewed and classified into half a score of categories.

It has been said that many industrialists take little account of the geographic qualities of site, chorographic or topographic. This study attests strongly to the fact that the great majority of steel and non-steel establishments—more than 85 percent—had definite geographic reasons for locating in Gary. The factorial importance of these reasons ranks in approximately the following descending order: site-building availability, market, transportation, semi-fabricated "raw" material, and labor.

Despite the primacy of steel, the Gary community today aspires toward a multiple manufacturing base of diversified industries. Thus the so-called "Gary Industrial Foundation, Incorporated," was organized in 1945 for the purpose of fostering "post-war industrial development" by acquiring and adapting sites suited to various industries.

Recent industrial planning and zoning are geographically evaluated, together with a consideration of the effects of changing intraregional and extraregional factors on the competitive position of Gary in national and world "Big Steel." Among them are: newly constructed thoroughfares, St. Lawrence Seaway, Sag Channel enlargement, prospective exploitation of Mesabi taconite ore, and new steel fabrications.

The authors used the historico-geographic approach, based on documentary material, questionnaires, and field survey.

A. A. MICHEL — *An Overexpanded Irrigation Project in an Underdeveloped Nation: Some Problems of the Helmand Valley Project in Afghanistan*

The irrigation projects in the Helmand Valley region of southwestern Afghanistan were initiated by the Afghan Government, which subsequently brought in an American construction firm. The projects mushroomed, and in 1950 and 1954 Export-Import Bank loans were made to help finance the work. The objectives of the Afghan Government were to raise living standards in the Helmand region and to provide land for the settlement of nomads and the resettlement of tenant farmers from other parts of the country.

Two storage dams and three large distribution systems have been completed, designed to assure a firm water supply to floodplain areas previously under cultivation and to new areas located on terrace lands. But overirrigation and unforeseen poor drainage have produced waterlogging, salinization, and some alkalization of soils. The newly settled farmers have generally been unable to cope with these problems and to make the necessary readjustments from their former way of life.

To help save the project, United States technical assistance was extended in 1952, and the International Cooperation Administration provided developmental funds to complete work in progress when loan funds ran out. But it remains to be seen how much of the project can be put on a remunerative basis in time to save dwindling American prestige in Afghanistan. Presumably, the application of a multifactor geographic approach in the early years could have identified most of the problems which have since arisen and could have suggested coordinated means of avoiding or solving them.

MARVIN W. MIKESSELL — *"Arabs" and "Berbers": A Problem in Cultural Geography*

In studies of North African ethnography, "Arabs" and "Berbers" are often described as separate peoples, differing in race and culture. It is now well established that this distinction has little meaning apart from the specific context of language. In Morocco and Algeria, few of the tribesmen who now speak Arabic are descendants of Arabians. In Tunisia, the amount of Arab "blood" is larger, but few

Tunisians can justly claim to be Arabians or Levantines. Indeed, the number of reasonably pure Arabs in North Africa is probably not much larger than the number of Spaniards in Mexico.

It seems best, therefore, to disregard the notion of a division of peoples in Barbary and refer instead to a process of assimilation. Two maps are offered to show the present distribution of Arabic and Berber speech. The first map, of the whole of North Africa, and the second, of northern Morocco, indicate the direction and rate of change. In general, Arab influence has been strongest in the environs of cities, where Arabic is the language of commerce and administration, and in rural areas of gentle relief, where communications are easy to establish and maintain. In the relatively inaccessible highlands, particularly in Morocco, Berber traditions of independence and self-sufficiency were not seriously challenged until the advent of European control.

EDWARD J. MILES — *The Geography of Political Attitudes: Some Methodological Considerations*

Studies in political regionalism have been largely the work of political scientists and historians interested in process or personality. Cartographic expression of spatial political patterns is rare. The few existing examples portray one election or one issue, often using units too large to be meaningful. It is in the systematic analysis "over space" and the correlation of resulting patterns with those of other cultural factors that the geographer can make his contribution.

Quantitative data are meaningless when isolated from either their spatial or chronological contexts. Causal factors relating to voting behavior must rest on detailed analysis of "who voted for whom, when." This can be answered best when election returns are analyzed spatially.

The purpose of this paper is to describe certain of the methodological techniques found successful in a study of political regionalism in New York State. The combining of spatial and chronological distribution of voting behavior and the mapping of the data by the smallest units possible were found to provide a valid abstraction from reality. The categorizing of party percentages and the historical

grouping of elections produces patterns of strength from which patterns of change can be derived. Patterns of consistency in voting compared with those of strength and change lead to certain conclusions about the political regionalism. Maps portraying these patterns have special value in revealing the areal distribution of party inertia and dynamism. With the establishment of political regions, attempts may be made to explain the reason for the voting behavior of specific areas for specific periods.

E. WILLARD MILLER—*World Patterns and Trends in Energy Consumption*

The roll call of the world's natural resources begins with those which are primarily energy-producing. The drama of man's last century of progress to the level of current living standards in this and other countries can be written in his conquest of coal, petroleum, natural gas, hydroelectric power, and thermal power. His ability to rise to higher levels of living will depend to a large extent on improved technology, development of new sources of energy, and on the ability to interchange energy sources.

The world's demand for energy has been rising continuously. For example, from 1870 to 1957 the world's output of coal rose from 234,000,000 tons to 2,140,000,000 tons. In the same period world petroleum output rose from 5,799,000 barrels to 6,645,000,000 barrels. There is every indication that this upward trend will continue. All nations are striving to lighten their labor burdens by utilizing greater energy resources. At present the world's consumption of energy is exceedingly unevenly distributed. In 1956 nineteen nations consumed about 90 percent of the world's energy.

Although the Age of Fossil Fuels has barely begun, its end is already in sight. In the years ahead the sources of energy will be greatly altered. The fossil fuels will gradually decline in importance. Although greater quantities of energy will come from solar, tidal, wind, and geothermic sources, these will prove inadequate. Nuclear energy will expand rapidly and after 1980 should represent a significant proportion of world power production.

VINCENT P. MILLER—*Paper Production of the Western Ontario Basin: An Example of Industrial Conflict and Adaptation*

The importance of the pulp and paper production of Eastern Canada in the world paper scene is well known; it is an industry producing mostly newsprint for an international market. The mills of the Western Ontario Basin, centering about Toronto, remain apart from the other paper-producing areas of Eastern Canada. The region's individuality and homogeneity stems from a production geared to local rather than to national or international markets. Of the region's 25 mills, only one produces newsprint; the others produce higher-value-added papers that have little appeal on an international market where tariffs discourage quality paper imports.

This anomaly has come about through the northward and westward shrinking of the forest raw material resource; as a result of human misuse, the established Western Ontario mills have been forced to "import" raw materials from increasingly greater distances. Newly established mills have located nearer to raw materials and power sources, and have thus reduced comparative production costs.

These changing economic factors necessitated realignment of the Western Ontario production; increased costs have made competition on the world's newsprint market difficult, while the local newsprint market could not sustain volume production. The result is a complicated cause-and-effect relationship that has brought about higher-value-added paper production, whereby mills produce purely for local consumption, export little, and economically tolerate no interference from outside producers.

The paper industries of the Western Ontario Basin illustrate the process of industrial conflict and adaptation; the conflict, born of a changing raw material environment, has only been resolved by a production transformation.

PALLE MOGENSEN—*Geographical Polar Navigation and Atmospheric Refraction at Low Angular Altitudes*

Polar icecap navigation as practiced today is a comparatively new but field-tested art; summer operations have been established with sound principles and operating techniques.

Actual geographical polar navigation, subject to the problems common to the Polar Regions in general and to the peculiarities of the region itself, was unknown until Operation Deepfreeze II. Problems of rigorous weather and extreme atmospheric conditions, together with insufficient knowledge of high-latitude, high-altitude refraction and of instrument and human capabilities, left much to be researched. In view of all this, the IGY South Polar navigational program was continued during Operation Deepfreeze III and was augmented by a refraction study. Environmental conditions, peculiarities, and problems, procedures, and celestial bodies observed are discussed and the conclusions drawn from the investigations are presented.

ROBERT B. MONIER AND HERBERT J. VENT —
*Color Slides for Geographic Instruction:
Public Domain Source*

Geography, perhaps more than any other discipline, is dependent upon simulating its subject matter. This is due in part to the nature of geography. On the one hand, geographers are interested in the physical phenomena. On the other hand, they are also examining areal associations. Such a wide range of study requires accurate and multiple simulation to achieve student understanding. Color slides offer additional facilities to the geography teacher.

The use of slides has been recognized as a necessity by all geographers. Until recently, however, their use has been limited by the lack of knowledge of their utility, by the lack of subject-matter coverage, and by the relative inconvenience of projectors and projection rooms. New equipment developments have opened the door for daily use of slides in classroom presentations. The lack of adequate subject coverage is still a major obstacle. Investigations to discover new sources of color slides have proved fruitful. The Education Division, Headquarters AFROTC, Maxwell Air Force Base, Alabama, has developed, under professional supervision, several sets of geography slides. Individually, each set provides coverage of a specific geographic phenomenon such as climate, maps and map projections, and the like. By selecting individual slides from different sets, it is possible to provide good coverage for many standard

geography courses found in college curricula.

The technical problem of reproducing the slides (now available only for 7 x 9 Vugraph projectors) for 35mm. projection has been resolved through direct photographing of the projected image from a beaded screen. Kodachrome 35mm. film was used and the resultant color slides were most satisfactory.

Since the source is public domain materials, the cost of preparing sets of slides or individual slides is held to a minimum. The original sets are wide in scope and accurate in detail, thus providing geographers with an opportunity to enlarge visual offerings in conjunction with their instruction.

ROBERT B. MONIER AND HERBERT J. VENT —
*Photo Interpretation: A Key to Radiation
Studies of Survivors of the Hiroshima and
Nagasaki Nuclear Explosions*

During the past ten years, the Atomic Bomb Casualty Commission has collected a large amount of medical data on the survivors of the Hiroshima and Nagasaki bombings. The ultimate objective of this effort (Ichiban Project) is the determination of the absorbed doses of fast neutron and gamma radiation received by individual survivors. This survivor-control group offers the best possible means of normalization of radiation effects, established by laboratory experimentation with animals, to man.

A critical requirement in such an endeavor is that the exact location and position of each survivor be accurately determined with respect to all surrounding objects that might provide a shield from the source of radiation. Since almost all materials have some shielding effect, it became necessary to place and locate all objects, in their proper relationship, to each cluster of survivors. With the total destruction that accompanied the explosion, combined with the loss of official (Japanese) maps, survey records, and other official city diagrams, establishment of small area models seemed almost impossible. The project directors attempted field observations, survivor interviews, neighborhood sketchings by former residents, and so on. None of these efforts produced sufficiently accurate planimetric maps.

As a result of established interdisciplinary committees, this problem was brought to the

attention of geographic consultants. Photo interpretation (photogrammetry) was considered to be the most feasible means of producing the needed maps. A pilot study was established to determine: (1) the availability of photographic coverage of the survivor areas; (2) the feasibility of compiling large-scale block maps showing cultural and planimetric features and contours.

The completed pilot map, at a scale of 1:700, is currently being field tested, and preliminary reports indicate that it is satisfactory. Subsequent verification will provide the basis for additional studies to provide block-by-block coverage of survivor clusters. In a practical sense, the use of photo interpretation methods has provided the necessary "key" for analysis of important medical research data.

JACK U. MOWLL—*The Economic Geography of Nuclear Process Heat*

The expected rapid growth of nuclear fission for producing electricity has been slowed by certain technical problems yet to be solved before production costs are brought down to competitive levels in most parts of the world. Emphasis has been given recently to the possibility of introducing nuclear reactors in various industries which use large quantities of heat in their processes. The same basic economic principles that determine the feasibility of nuclear electric power apply to the problems of introducing nuclear process heat. These are related to the transport costs of conventional fuels. However, process heat reactors can operate at low temperatures and low pressures, thereby avoiding the technical problems involved in the higher-pressure and higher-temperature electric generating systems.

This combination of circumstances makes it possible for nuclear power to compete favorably with conventional fuels in the production of process heat for remotely located paper and pulp, chemical processing, and certain food processing industries. A representative sample of these industries has been surveyed and they report that conventional fuel costs have risen from 20 to 50 percent in the past five years, largely as a result of increases in transportation costs. They report also that the cost of producing steam at many existing facilities is

higher than could be produced by nuclear systems.

Development of the process heat reactor and its acceptance by industry may be an effective factor in changing the map of industrial location. Many industries chained to fixed power sources may move further out into areas where they can be truly material-oriented.

C. JOSEPHINE MOYER—*The Psychological Factors Operating Against Incorporation of Greater Reading*

"Greater Reading" is the name locally applied to an urbanized area of southeastern Pennsylvania that comprises Reading (the central city), twelve incorporated boroughs, and the urbanized regions of seven townships. It covers an area of 26.4 square miles.

This region has long been known for iron and steel manufacturing. In recent years there has been an increase in textile manufacturing, which today competes with the manufacture of metals for first place among the industries of the area. The manufacturing plants are well distributed throughout the entire conurbation. Three rich agricultural valleys, along which Greater Reading developed, contribute to the commercial function of the central city and give easy access to the eastern section of the Industrial Belt. As a result of the suburban movement in the early part of the century, Reading is now almost entirely encircled by the incorporated boroughs, leaving no land for expansion of either industry or residence. This encirclement has accelerated the rate of decadence for the adjacent boroughs as well as for the central city, with a resultant loss in population and business.

It is the purpose of this paper to analyze the geographical structure of the area, to trace the origin of the various political units, and to analyze the factors that originally motivated the suburban movement for their current values, in order to show that the basis for political separation is psychological rather than geographical. The areas of cooperation across political lines, a comparative tax structure for the area, and the homogeneity of the ethnic group are among the subjects discussed.

PETER H. NASH—*Interdisciplinary Approaches to the Study of Emerging Polynuclear Metropolitan Regions*

Continually accelerating population shifts toward large urban centers have focused increasing scholarly and professional attention on emerging forms of metropolitanism. Stimulated by numerous grants from foundations, a dozen polynucleated urban regions are on the analyst's couch. Geographers are involved in two major capacities: first, they supply salient distribution data to other researchers; second, they utilize their own professional methods and techniques, not only for areal analysis and synthesis, but also to sink shafts into specific problems, particularly those that promise solution via interdisciplinary cooperation. Superposition of coarse-grained lattices, constituting double "slices" of historical development, yielding land use patterns and gross expressions of movement, are cases in point. Another example is the evaluation of "control systems," in terms of adequacy for solution or prevention of development problems, to aid in the formulation of planned direction.

A useful symbiotic relationship between basic and action-oriented research has emerged from the Urban Studies Program of the Institute for Research in Social Science, University of North Carolina. The Polynucleated Piedmont Industrial Crescent serves as a focus, where intellectual frameworks are fused and where working biases and values judgments are critically adjusted. Although research first centered only incidentally on geographical characteristics, such areas of investigation as community leadership roles, newcomer attitudes, decision-making processes, consumption patterns, professional planning effectiveness, livability standards, legal tools, annexation criteria, and communication networks, soon synthesized varied salient data, contributing heavily to the geographical knowledge of the region. Interdisciplinary explorations not only add largely to our areal knowledge, but also point toward further research, both basic and applied.

THOMAS B. NOLAN—*Research and Our Natural Resources*

The dependence of our economy upon mineral raw materials causes recurrent concern

about the adequacy of our supplies. Minerals are a nonrenewable resource, and the predictable exhaustion of sources of supply known at any one time, combined with the population increases anticipated by demographers, provide the basis for concern. But in spite of increasing rates of consumption for increasing numbers of commodities, our known supplies of most of them have been maintained at a level that always places apparent exhaustion some years in the future.

The reason for this anomaly lies in the effectiveness of research by scientists and engineers who work in the raw materials field. Their work has resulted in new or potential production from sources that were formerly unknown or were regarded as unsuitable; parallel advances in technology have brought about the utilization of substances that supplement or entirely replace certain materials in critical supply.

Several fields of research have contributed to this expansion of our resource base. These include research on the origin, and on factors controlling the localization, of mineral deposits and the development of the means to locate them; research on subgrade and ultra subgrade material as sources of supply, and new metallurgical techniques to treat successfully such material; and research on the basic physical and chemical properties of the elements and compounds, in order to acquire the ability to develop synthetic or substitute materials.

The success of this research to date suggests that our economy is dependent as much on full utilization of our intellectual resources as on raw material supplies now known to exist.

ROBERT E. NUNLEY—*Regional Geography and the Distribution of Population in Costa Rica*

This paper pleads for an analytical approach to all regional geography and suggests one way this can be accomplished. It suggests that, by asking and answering a few basic questions concerning the distribution of population, all the facts of the physical and cultural landscape generally considered in a regional geography can be woven into a stimulating, meaningful study.

An analysis of Costa Rica serves as an illustration. A detailed map of the distribution of population in Costa Rica provides the basis

for questions and portrays the components of what might be called the geographic structure of population. Several generalized maps show the evolution of the geographic structure of population, giving ample opportunity for observations on historical geography. A map of the regions and districts of population reflects all major variations in both the physical and the cultural landscape of Costa Rica. (A brief discussion of the techniques and concepts used in compiling the data on Costa Rica shows the practicality of such an approach.) Thus the many interrelations among physical and cultural facts assume a logical and useful place in an analytical regional geography.

HOWARD L. OHMAN and IVEN BENNETT—
Oasis Modification of Desert Temperature and Humidity

Desert weather stations frequently are located in oases where plant cover and soil moisture differ sharply from the surrounding desert. Under these conditions, temperatures and humidity may be representative for the oasis area only and have little relation to conditions in the open desert. Rarely does one encounter in climatic studies of arid regions evidence that this bias in the data has been considered, possibly because its quantification seldom has been attempted.

Measurements made in summer in and around the Yuma, Arizona, oasis give an indication of the magnitude of this modification in at least one oasis. At standard instrument height, daytime transpiration and evaporation within the oasis depressed air temperature 5 to 10 degrees (F.) and elevated dew point as much as 8 to 12 degrees compared to the nearby desert. At night the oasis effect was even more pronounced. Moderate nighttime evaporation and small storage of heat in the soil within the oasis, contrasted with negligible evaporation and large heat storage in the soil of the desert, combined to produce temperatures 5 to 15 degrees lower in the oasis than in the adjoining desert. Nighttime dewpoint differences depended on the type of air mass dominating southwestern Arizona, ranging from 5 to 10 degrees higher in the oasis when humid air masses prevailed, and 15 to 20 degrees higher when dry air masses were predominant. During both day and night, advec-

tion of oasis influences into the desert was limited to less than one mile.

JAMES J. PARSONS—*Fog Drip from Summer Stratus, with Special Reference to the Berkeley Hills*

Rain gauges mounted under Monterey pine and eucalyptus trees on the crest of the Berkeley Hills, California, at an elevation of 1000 feet above sea level have recorded up to 10 inches of fog drip during a single summer, equivalent to nearly one-half of the average rainfall of the area. In one instance 1.03 inches were recorded during a single night. All of this moisture has been wrung from the stratus that rests on the crest of the hills during much of the summer and early fall. This fog drip is a nighttime and early morning phenomenon; air temperatures typically lie between 48° and 50°F. when fog drip is registered; wind speed seems to control its intensity. On foggy mornings the ground is saturated under and on the lee side of all larger trees along the crest; water stands in puddles under the trees and runs in the gutters. It is apparent that significant amounts of water might be extracted from California coastal stratus in favored situations by tree planting or by barriers erected to sieve out the fog droplets from the air.

The literature on cloud drip and fog drip is not extensive. Plantations of "fog prevention forests" of fir and spruce on Hokkaido are reported by Japanese foresters to have reduced significantly the water content of the advection fogs that persist there, thus opening the way for a more intensive agricultural land use. It has been noted that trees also induce precipitation from the stable air that forms the characteristic hugging cloud caps on high trade-wind islands such as the Canaries, the Lesser Antilles, and the Hawaiian group. Where there is a forest cover sufficient moisture may reach the ground to support flowing springs and streams during the rainless months.

GEORGE P. PATTEN—*Problems Facing the Nicaraguan Dairy Industry*

Specialized dairy farming is a recent innovation in Nicaragua's Central Lowland. Dairy-men face many production and distribution problems, but their eventual success seems assured as growing urbanization, higher pur-

chasing power, and government encouragement foment increased demand for dairy products.

Production is impaired by consistently high temperatures which result in a serious insect and disease problem, make milk cooling and handling difficult, impede high quality pasture growth, and adversely affect dairy cattle. During the rainy season, soil leaching causes mineral deficiency in grass. The dry period renders grass unpalatable and protein poor. A low water table, which hinders water procurement, occasionally limits water consumption of cattle. Poor pasture management and insufficient supplementary feeding result in malnutrition, which restricts milk production, and sometimes causes death. Herds are mostly of low-producing native stock, which are seldom upgraded scientifically.

Milk distribution problems are imposed by inadequate transportation facilities, a limited market, a paucity of home refrigerators, and low quality raw milk. A modern pasteurizing plant recently established in Managua is faced with the additional problem of consumer resistance; potential customers are suspicious of milk quality because of the low standards maintained by previous pasteurizing plants.

Various government agencies and the enlightened dairymen are cooperating to improve all phases of the industry. Present-day progress seems to indicate future solutions of the most serious problems. Dairying will quite likely become an increasingly important adjunct to the Nicaraguan economy.

G. ETZEL PEARCY—*Measurement of the United States Territorial Sea*

The territorial sea of the United States, traditionally three miles in breadth, is an offshore zone measured seaward from the coast. Over it sovereignty of the United States is complete, although ships of other states are normally accorded the right of innocent passage. Seemingly simple by definition, the precise delineation of the territorial sea entails situations fraught with perplexing problems. Sinuosities of the coastline, islands, and tides all contribute heavily to the difficulties of measurement.

As a point of departure the *baseline* serves as the inner margin of the territorial sea. From

it is measured the outer limit, uniformly three miles distant. Commonly the mean low water line along the coast is taken as the baseline. But mouths of rivers, estuaries, bays, inlets, and other indentations break the coastline and require special rules of procedure in determining a baseline. Islands, either singly or in combination, are entitled to baselines of their own, thus extending seaward the three-mile zone of territorial water or creating additional noncontiguous zones. Particularly difficult to evaluate are the innumerable "low tide elevations" that exist above the surface only at some stages of low water.

The smooth coast of New Jersey presents only a few problems in the measurement of the territorial sea, but what of the "rock-bound coast" of Maine, the Florida Keys, or the Mississippi Delta? Is Santa Monica Bay legally a bay, or is it a mere curvature of the coast? These and other problems require skill in analyzing the physical geography of coastlines.

ADAM A. PEPELASIS and KENNETH THOMPSON—*Institutional Limitations to Land Resource Development in Greece*

The low level of economic development in Greece is commonly attributed to poverty of natural resources. However, resources are not limited to a fixed quantum of naturally endowed wealth for man's potential use or neglect. Individual and collective attitudes toward natural endowments are themselves an important resource. There are several examples in which human drive for economic development, in suitable historical circumstances, has overcome all but the most gross resource deficiencies. It is true that Greece must be ranked among the poorer nations of Europe, but its resources are not inconsiderable. They include mineral wealth, fisheries, water for power and irrigation, and certainly greater land resources than the present condition of agriculture might suggest.

Although agriculture is predominant in the Greek economy (accounting for about 40 percent of national income and employing more than 60 percent of the labor force) it has nevertheless remained underdeveloped—in large part because of the institutional milieu and value systems of the country. Among the major institutional barriers to development of Greek land resources are: general attitudes

toward work, resistance to innovation, educational values that emphasize classicism rather than pragmatism, inadequate agricultural credit, channeling of savings into "non-productive" uses rather than into land development, a legal system that until recently reflected Byzantine economic conditions with only limited relevance to the modern economy, small-sized and fragmented peasant farm units, and the consistent past failure of government to encourage development in the agricultural sector of the economy.

JEROME P. PICKARD—*Functional Size and Regional Location of Major Metropolitan Areas of the United States in 1956*

There were 68 metropolitan areas in the United States in 1956 of second-order or larger functional size. Of these, 35 were located in the Atlantic Metropolitan Region and 33 in the outlying regions. New York, the national metropolis, was of eighth order; Chicago, seventh order; and Los Angeles and Philadelphia, sixth order.

Nine metropolitan areas ranked in the first quartile in all six functions measured—New York, Chicago, Los Angeles, Philadelphia, Boston, San Francisco—Oakland, Detroit, St. Louis, and Baltimore. These may be considered as the principal, well diversified, national metropolises. Two additional principal areas, Pittsburgh and Minneapolis—St. Paul, are below the first quartile only in federal government employment.

Of the 68 metropolitan areas, 22 have a sufficiently high development of metropolitan functions to be classified as "specialized" in combined function; one, Des Moines, is "concentrated."

The Atlantic Metropolitan Region contains 16 metropolises. New York occupies a pivotal location in this region, and average and median distances between metropolises is the least here. In the Great Lakes—Midwest Metropolitan Region there are 19 metropolises. The median size is largest in this region, and manufacturing is relatively of the greatest importance. The Southeast has two leading regional metropolises, Atlanta and New Orleans; the Southwest has two, Dallas and Houston; the Midwest has two, Minneapolis—St. Paul and Kansas City; and the West has two, Seattle and Denver. In Florida, in the

Southwest, and in the southern part of the California Metropolitan Region, metropolitan growth has been very rapid in recent years, and functional development is not as advanced. Los Angeles is by far the largest metropolis in these regions of new growth; no other exceeds third-order size. San Francisco—Oakland (fifth order) in the California Metropolitan Region has well developed functions.

The 68 metropolitan areas contained 45 percent of the national population in 1956, and 63 percent of the combined metropolitan functions.

PHILIP W. PORTER—*Historical Geography of the Peopling of Liberia*

This paper seeks to document, in a series of maps, the following arguments: (1) that Liberia stood remote from the course of empire in the grasslands of the Western Sudan until the eighteenth century; (2) that the forested highlands served as a refuge for successive tribal groupings, displaced southward by more powerful neighbors; and (3) that the morphology of settlement reflects in large measure the influences of the past 75 years.

Although settlement by "West Atlantic" speaking Sudanese peoples predates Portuguese exploration of the coast, much of the peopling of the country took place in the eighteenth and nineteenth centuries. Moreover, present-day settlement forms are a product essentially of military, political, and economic events since 1870. Evidence of the awesome power of the Malinke chief, Samory, and his horse-riding Sofa warriors, is seen in the crumbling mud fortifications that surround many hinterland villages. In areas that have long been under Americo-Liberian administrative control tribal boundaries are no longer distinct on the population map. The Firestone rubber estates and postwar economic developments have greatly altered the pattern of settlement. Only in areas remote from recent influences do well marked tribal differences in settlement form persist.

The paper focuses attention on the recency of the peopling of Liberia, and on the great instability of the settlement pattern when subjected to external pressures. Through its use of large-scale maps of population, the paper demonstrates the utility of accurate population maps as an aid to research in understand-

ing the past of an area whose history is largely unrecorded.

ERWIN RAISZ—*The Atlas of Florida*

The idea of an atlas of Florida originated with Dr. Sigismond de R. Diettrich, and in 1954 the author made a rough layout for such an atlas. Some preliminary work was done in 1957, but it was not until 1958 that the actual work was begun by the author and some student assistants.

The purpose of the atlas is educational; the volume is intended for high school and college students and for the educated public. It consists of maps, diagrams, sketches, and text. The text will be written by Dr. Diettrich.

The plan calls for 52 pages (11×13½ inches). Of these, 14 pages will show physical attributes (for example, location, geology, climate, hydrography, soils, and biology); 5 pages will be devoted to archaeology and history; 10 pages will deal with economic factors (agriculture, manufacturing, forestry, minerals, and transportation); and 14 pages with social conditions (population, wealth, health, education, culture, government, and tourism). No large-scale maps are planned. A state road map will be added.

The atlas is to be printed in four colors and should be ready for the color-separation artist in February, 1959. The work will be published by the University of Florida Press.

HERBERT L. RAU, JR.—*The Impact of a Technical Assistance Program on Agricultural Land Use Patterns in the Sabana de Bogotá, Colombia*

The technical assistance program of the Rockefeller Foundation in the Sabana de Bogotá is having a significant impact on agricultural land use patterns and production. In 1951, Colombia invited the Rockefeller Foundation to cooperate in an agricultural development program, the *Oficina de Investigaciones Especiales*. The aim of the Oficina is to expand domestic production and quality of grains in the highlands, and thus decrease dependence on foreign purchases. From the experimental farm established at Tibayatá, in the Sabana, improvements in types and productivity of wheat, barley, maize, pasture grasses, and beef and dairy herds are bringing changes in agricultural land use patterns.

First, more land is being drawn into seasonal and year round open-field cultivation; second, pasture land is becoming restricted and is being exploited more intensively; third, yields of wheat, barley, and other crops are increasing. From this experiment in economic development, Colombian dependence on imports of grains from abroad, particularly wheat, has been reduced substantially.

Strides forward in the agricultural sector of the Sabana economy have resulted from an over-all betterment of crop productivity and livestock quality made possible in the temperate climate of this tropical highland basin.

The land use patterns, crop productivity, and livestock breeds in the Sabana de Bogotá have changed over the past 25 years. A large-scale shift from a predominant pasture land use pattern to open-field cropping has occurred since 1948. In an established society where crops and farm methods have been governed by tradition, a private technical assistance program is promoting the development of a modern, productive agricultural economy.

JOSIP ROGLIC—*Geographic Thought in Yugoslavia*

Scientific thought and scientific work in small countries, and thus also in Yugoslavia, reflect the achievements abroad and the limitations at home. Interest in geography is very old in Yugoslavia, but geography as a science is relatively young. Local historiography and the teaching of history and even of the Bible supplied information, often erroneous, of the lands where the narrated events had taken place. This narrative method is a cumbersome inheritance for geography.

The organization of integrated national life and the universal influence of industrial progress during the nineteenth century called for thorough knowledge of one's own country and increased interest in the rest of the world. Accurate maps and statistical data formed the material basis for this evolution. Numerous names and figures have been added to the inherited narrative method—a procedure from which our discipline is laboring to free itself—particularly as regards the teaching at secondary-school level, which reaches the educated general public.

The establishment of Chairs of Geography

(Zagreb, 1884; Belgrade, 1905; Ljubljana, 1918; Skopje, 1922; Sarajevo, 1949) did not solve the problem. The first professor (S. Matkovic at Zagreb) was trained as a historian, and thus it is understandable that the notion of geography as the handmaiden of history continued. This conception was then dominant in most European countries, where the humanistic system of education was deeply rooted. However, J. Cvijic, educated at the famous Viennese school by A. Penk, succeeded in securing an independent and respected position for geography.

The problem of Yugoslav geography is the common problem of our discipline, conditioned by general and local circumstances. The two World Wars, with the manifold subsequent changes, have shown the need for thorough knowledge of the world around us; and the scientific and industrial achievements have made us citizens of the world and have made neighbors of all peoples who, however, know one another insufficiently well. This discrepancy is one of the chief sources of the present world problems and world conflicts.

The progress of life requires geographic knowledge, and it is up to the geographer to provide it. Just as the discipline, subservient to another science and using its methods, was unable to fulfill the task, so it is impossible to do so by specialized limited observation of parts of the geographic object. From its subordinate position, geography is apt to intrude into other fields, though its own is wide enough and clearly defined. Why then this avoiding of its own proper object and this crisis of method in geography? We believe the reason lies in the magnitude of the geographic object, in the seeking of the easiest way, and in the lack of an adequate method. The facts of space are inexhaustible, but their correct interpretation is only possible if their past development is known. Their comparison sharpens the critical geographic sense and forms an individual conception of the world. Unfortunately this philosophic conception is achieved only at the end of a lifetime, i.e., by personal endeavors of the individual geographer. We believe the cause of it lies in the weakness of the geographic educational institutions and scientific methods.

The present-day tasks of geography require, and technical achievement makes it possible for, geographic education to provide a firm

foundation for complex understanding and critical interpretation. From this firm foundation great and original successes will best be attained.

Many of us in Yugoslavia believe that geography should draw the conclusions that are required by the critical epoch in which we live.

ANTHONY SAS—*Some Problems Associated with the Integration of Dutch Rural Settlers in Southwestern Ontario*

Any large-scale migration to a new country by people having different background, customs, and tradition creates special problems concerning the integration of the newcomers into the established society. Close investigation of such group movements may well reveal facts that can explain in more detail economic, social, and cultural patterns in the settlement area.

Although postwar settlement of more than 12,000 Dutch, primarily farmers, in four counties of southwestern Ontario has not resulted in violent social upheavals, it nevertheless has given rise to problems whose impact has been felt by the area and among the immigrants.

Apart from the economic difficulties that most of the adult family members had to face during the first years after arrival, one of the major problems concerned their adaptation to and merging into the Canadian community. Inability to cope with the English language, differences in outlook and culture, and activities by certain churches in the area have tended to insulate the settlers and to make them stay within their own group. Such symptoms as a reluctance to marry outside the group or to take out citizenship papers can be advanced as evidence of this lack of integration.

Another problem has been that of preserving family solidarity, which has been threatened by an apparently more democratic way of life in the area, the greater freedom of Canadian children (affecting immigrant teenagers), and the ability of immigrant children to master the new language quickly while often neglecting the mother tongue.

FRANK SEAWALL—*Transportation Regions of the Monongahela River*

The principal objective of this study is the division of the hinterland of the Monongahela

River into transportation regions. This regional division is based on an analysis of the functions of the river terminals, the movement of commodities to and from the river terminals, and the unification of areas of similar river transport characteristics into transportation regions. As a result the hinterland has been divided into four regions.

The Northern Gasoline, Sand, and Gravel Consuming Region has a relatively limited river frontage. However, this region receives the bulk of the gasoline, sand, and gravel terminating on the Monongahela River. The populous Pittsburgh area serves as the core and the principal market for these commodities.

The Industrial Trading Region consists only of the immediate valley of the lower Monongahela River. Practically all coal shipments terminating on the Monongahela River are received within this region. Other basic industrial commodities received are semifinished iron and steel, scrap metal, industrial fuel oil, sulphur, and sulphuric acid. The Industrial Trading Region ships finished and semifinished iron and steel products, and various chemicals.

The Coal Shipping Region is basically the area in the middle Monongahela River from which coal is mined for river transport to downstream markets. This region is one of the major coal mining regions in the world, with several mines shipping more than a million tons of coal annually on the Monongahela River.

The Southern Gasoline, Sand, and Gravel Consuming Region consists of the upper portion of the Monongahela River hinterland. By comparison this is a relatively large region, but the total traffic is meager and is limited to gasoline, sand, and gravel.

KERLIN M. SEITZ—*Milwaukee's "Outside, Inside, Outside" Harbor*

The reconstruction of the physical aspects of an area at given times provides a better understanding of the present and past geography of that area. This paper is such a reconstruction for the harbor area of Milwaukee, Wisconsin. The harbor facilities have moved from the lake shore into the river valleys and back to the lake shore in the past 124 years.

The original site in 1835 could hardly be recognized from the present scene. The shore

line was a steep cliff some 60 to 70 feet high, broken only where the Milwaukee River and its tributaries in their entrenched valleys flowed into the lake. A sand bar extended across the river's mouth and the swampy lagoon behind it merged with the equally swampy flood plains of the three rivers.

In 1857, the early piers on the lake shore and shallow river mouth were abandoned in favor of a "straight cut" dredged through the bar. This provided access to the Milwaukee River; wharves were built along the river and the wet lands behind it were filled. Beginning in 1868, the Menomonee Valley canals were dredged and the swamp areas covered with 21 feet of fill.

The modern harbor was begun in 1923. Improved breakwaters protect the made land that was extended from the old shore and dredging permits ocean-going ships to use new piers on the lake front and in the basin enlarged from the old lagoon.

JOHN RICHARD SHEAFFER—*A Geographic Approach to Stream Classification: Flood Events*

In developing a systematic classification of streams, one factor that deserves analysis is the flood event.

The segment of the concentration curve of a flood hydrograph which is contained between flood stage and flood peak can be referred to as the flood-to-peak interval. This interval is a variable unit of time. Empirical data were utilized to establish three meaningful classes of this interval.

With regard to major floods, the flood-to-peak interval serves as a parameter of actual damage, since it limits the adjustments, or the opportunities for them, which can be undertaken in order to mitigate flood damages. The proportion of actual damage to potential damage will tend to be greatest when the flood-to-peak interval is of short duration.

It is hypothesized that a correlation exists between flood-to-peak interval for maximum flood crests and the size of their drainage areas. This hypothesis has been tested by utilizing a stratified regional sampling of gauges located in the Ohio Basin and at a selected group of urban places throughout the United States. The results of these analyses reveal that a correlation does exist and that it should

be possible to estimate, with a fair degree of accuracy, the flood-to-peak interval of a maximum flood crest if the drainage area is known.

JAMES A. SHEAR—*Some Observations on Ant-arctic Circulation*

As a result of the International Geophysical Year program our knowledge of high latitude circulation in the southern hemisphere is increasing at a rapid rate. Although the official IGY has only recently been completed, fragmentary data have thrown new light on the gross circulation picture of the Antarctic.

The idea of a "fixed glacial anticyclone of great vigor which spreads beyond its borders," developed by Hobbs for Greenland and postulated for Antarctica, does not hold up in the preliminary findings. Although high elevations and low temperatures make the calculation of sea level pressures a hazardous task, surface synoptic charts reveal the frequent presence of cyclonic circulation near the pole itself. The monthly average circulations at the 700, 500, and 300 mb. surfaces also show strong cyclonic development rather than anticyclonic.

Outflowing surface winds near the coast appear more as a gravity-flow phenomenon of little depth and reach great intensity only under the influence of passing depressions that move around the continental periphery.

The long-held concept of a strongly zonal circulation is well supported by the recent data. The possibility of outbreaks of Antarctic air penetrating to mid-latitudes is not ruled out but is of relatively rare occurrence. If anticyclonic conditions exist, they are limited to a shallow depth probably associated with the inversion layer.

PAUL D. SIMKINS—*New Maps of Population Distribution in Central America*

The maps presented are based on the 1950 censuses of the Central American Republics and show population distributions based on data for minor civil divisions. Maps and data giving the boundaries and areal extent of minor civil divisions were obtained from the various census offices in Central America. However, the maps obtained from these offices were of widely varying scales. To bring them to a common scale, the coastal outlines of Central America were first drawn at a scale of 1:1,000,000 and the maps of the minor civil

divisions were then photostatically enlarged or reduced to fit the coastal outlines previously established.

The prepared maps include a choropleth map, an isopleth map, and a dot-distribution map.

DAVID S. SIMONETT—*The Role of Rainfall in Soil Formation on the Basalts of North Queensland*

The Pleistocene and Early Recent lavas of the Cairns-Atherton district of North Queensland, Australia, have developed an interesting sequence of soils in response to differences in climate. Since both temperatures and parent material (basalt) are relatively uniform in this area, rainfall is the most significant variable in soil formation.

In the lower-rainfall areas (30 to 35 inches a year) Tropical Black Earths occur in catenary association with soils that appear to be analogs of the Low Humic Latosols of Hawaii. The high-rainfall areas (100 inches or more) have Humic-Latosol-like soils. In the intermediate-rainfall areas are transitional catenas and soils that emphasize the gradational nature of change in soil properties in response to change in annual rainfall.

This study analyzes the changes in clay mineral composition, inherent fertility, physical characteristics, soil-profile morphology, and soil-use problems as a function of rainfall for eleven profiles that straddle the savannah woodlands of the low-rainfall area, the dry sclerophyll forests of the intermediate zone, and the rain forest of the high-rainfall district.

The major finding is that despite striking variations in profile morphology, the soils nevertheless fit readily into a continuous soil property-rainfall function on the basis of laboratory analysis. In general the results agree well with those obtained by Tanada in Hawaii on similar soils, and the weathering sequence matches closely the weathering scale postulated by Sherman and Jackson. Several soils that may be worthy of recognition as independent Great Soil Groups are described in some detail.

DAVID A. SMITH—*Contrasts in Inter-Island Transportation in the Hawaiian Islands and the Lesser Antilles*

This paper is an attempt to explain the great differences in the inter-island transportation

systems of the Lesser Antilles and the Hawaiian Islands. It deals with differences both in types of transportation and in the patterns that inter-island transport creates.

In the Hawaiian Islands, the pattern of transportation is roughly that of a wheel, with Honolulu at the hub. By far the greatest amount of movement within the chain takes place between outlying ports or airports and Honolulu. This is true of both air and surface transportation. In addition, transportation in the Hawaiian Islands has followed a logical development, constantly striving for increased efficiency and lower costs through the adoption of new equipment and methods of operation.

The pattern of inter-island transportation in the Lesser Antilles is one of several clusters, each with a different island as its nucleus. The means of transport in the eastern Caribbean also differ from those in the Hawaiian Islands. The industry has tended to stagnate, with changes in equipment and methods taking place very slowly. Thus, sailboats are still predominant, with motor vessels a relatively recent innovation. Although the airplane is present in both island groups, its role in transportation in Hawaii differs strikingly from that in the Lesser Antilles. In Hawaii, it is a major carrier; in the Lesser Antilles, a supplementary one.

No one factor can account for these divergent developments and the patterns that have been created. Rather, a number of factors are responsible, among them differences in the political and economic geography of the two chains, and contrasting population distributions.

OTIS P. STARKEY—*The Transit Trade of Barbados*

Barbadian merchants were able to develop an important transit trade because: (1) Barbados was the first of the southern Antilles to be sighted on voyages from Europe, Africa, and Brazil; (2) Barbados was fully settled when the other islands, generally much more rugged, were largely wilderness; (3) Barbados had more frequent shipping services and lower freight rates than neighboring islands; (4) early sugar profits supplied capital; and (5) the early development of Barbados attracted regional governmental, commercial, and professional headquarters.

During most of the nineteenth century re-exports accounted for between one-sixth and one-quarter of the total exports. In part because of the declining value of the sugar trade after 1895, the relative importance of re-exports increased and often amounted to one-third of all exports. After the sugar crisis of 1921 re-exports declined to less than one-tenth of all exports.

Barbadian trade has been handicapped by the necessity to use lighters to load and unload large steamers. By investing \$12,000,000 in a deepwater harbor, the government of Barbados expects to rebuild the transit trade.

CHARLES T. STEWART, JR.—*The Hinterland Reconsidered*

The term "hinterland," or area tributary to a seaport, has been generalized to "service area" whose obverse is the central place. In advanced regions the city with its hinterland is no longer self-contained. A honeycomb of disjunct hexagonal cells is not a realistic spatial arrangement of human activities.

The overlap of adjacent service areas is as important as their diverse gravitational pulls. Common market and supply areas characterize most cities. Prominent features of human geography are bounded by political and cultural divides, not by frictions of space. Many activities are regional in origin, and lack a spatial center.

On introducing a city hierarchy, graded by function and incidentally by size and numbers, we divorce functional from purely spatial aspects of human activity. When most functions no longer have similar unit areas, a spatial approach is inadequate.

A functional approach to macrogeography is suggested by the urban-base concept. A city is described by its export "industry"; the institutional composition is determined by export-complementary facilities and by the needs of the induced population; total population is derivative. Any region homogeneous with respect to its export base is a suitable unit. Regions are delineated by criteria emphasizing geographical interdependence, not self-containment.

An interregional trade matrix computed from a series of unit-region studies could show both the direction and the extent of interdependence between any two regions. A schema

of spatial relations for any region can be obtained in the form of a trade flow network.

WILLIAM B. STOCKDALE—*Population Movements as Effected by an Upper Ohio River Basin Flood Control Project*

High floods have inundated the extensively developed valleys of the Pittsburgh and Upper Ohio River region from time to time. Since the disastrous flood of 1936, the federal government has completed eight flood control reservoirs on the tributaries and upstream areas of the Allegheny and Monongahela Rivers. One of the recently completed projects, the Conemaugh River Reservoir, involved the acquisition of an area containing more than 2000 persons and has brought significant changes to areas that have remained relatively unaffected over the years. Several communities lost a considerable proportion of their population and a few were completely abolished.

The files of the Corps of Engineers contain ample information regarding pre-project family distribution. However, no data have been compiled by the Corps's Pittsburgh District relating to the places of relocation of the some 550 dispossessed families or their resettlement methods (e.g., moving houses intact or building new houses). The author undertook a field survey to determine the answers to these problems. Results showed that although distances moved ranged from less than 200 feet to more than 2000 miles, more than one-fourth of the families relocated within half a mile of their former homes and more than 50 percent of the families relocated within two miles. Less than 18 percent moved more than ten miles. This indicates the strong attachment of these families to their local environment and the lack of desire to relocate elsewhere—in many instances not even in areas closer to their employment.

KIRK H. STONE—*Norwegian Frontier Settlement*

The Norwegian frontier of settlement is the area between the populous southwestern and southern coasts and the unpopulated parts of the Norwegian-Swedish border. This area is a zone that is divisible into three parts: the sea frontier, the inner land frontier, and the outer land frontier.

The sea frontier is the narrow coastal strip between Trondheim Fjord and the Norwegian-Soviet border; the inner land frontier is south-central Norway inland from the populous coasts; and the outer land frontier is a belt on the west side of the unpopulated land and between it and the inner land frontier or the sea frontier. The three frontiers are distinguished on the bases of patterns of distribution and densities of population, facilities for transportation, portions uninhabited, urbanized agglomerations, personal and public services available, export staples, and occupations of the inhabitants.

Analysis of each area is in terms of relative present-day permanence of settlement. Particular attention is directed to those parts of Norway where recent methods of settlement have resulted in a high degree of permanence; similar methods might be used in new frontier settlement efforts in northern North America.

LEERIE SUMMERS—*The Evolution of Shaded Relief Portrayal on Aeronautical Charts*

Utilization of shaded relief portrayal on aeronautical chart series has changed markedly, based on adequacy and type of source material, new chart uses, and capabilities of compilation personnel.

The first extensive use of shaded relief on USAF Aeronautical Charts was in the Aeronautical Approach Chart Series on the scale of 1:250,000. This shading was compiled by using the streams, contours, and elevations of the original compilation as control. Later, shaded relief was compiled from source material in areas which had relatively unreliable relief information—for example, form lines, hachures, or shading. Shaded relief was the only method of relief portrayal used in these areas. Malaya was a typical example. Where good photo coverage was available, as in Iran, relief was compiled photogrammetrically, and the result was an intricate pictorial relief portrayal.

Low-level flight concepts presented a need for relative relief portrayal supplementing elevation on the 1:500,000 and 1:1,000,000 scale series. This was the first use of shaded relief on series other than the 1:250,000. Pictorial relief and a much closer contour interval were employed. Supplementary methods included

the use of a light green tint on relatively level areas and valleys, light yellow on hilly areas, and bright yellow on mountainous areas.

Pictorial relief and spot elevations depict relief on the new Global Navigation and Planning Series on the scale of 1:5,000,000. This type of terrain representation in a planning series gives a much more rapid impression than can be obtained by the interpretation of contours. Present and future aircraft navigation require immediate understanding of the nature of the terrain by navigator and pilot. Although the compilation of shaded relief is somewhat more difficult than the compilation of contours, the production of charts having this type of relief portrayal is now justified.

EDWARD J. TAAFFE—*The Urban Hierarchy and the Gravity Model: An Empirical Definition*

The concept of a hierarchy of urban centers has recently been investigated in both theoretical and empirical studies. This paper represents an empirical examination of the upper level of the urban hierarchy in the United States as it is reflected in the flow of air passengers between large metropolitan centers. This hierarchy as it exists among the 100 or so largest air-passenger generators is subjected to map examination in order to determine patterns of dominance, trends in degree of dominance, and correlation between dominance patterns and the gravity model formulation.

The maps indicate the over-all dominance of New York, Chicago, and Los Angeles, as well as of certain regional centers (or pairs of centers) such as Atlanta, Dallas-Houston, and Portland-Seattle. From 1940 to 1955, the largest metropolitan centers, particularly New York and Los Angeles, expanded their area and degree of air-passenger dominance and became more tightly linked with each other and with secondary centers in a set of increasingly hierarchical linkages.

Although the gravity model in its unmodified form is seen to have important shortcomings as a description of these air-transport dominance patterns, it does serve to underline the weakness of the distance effect. The introduction of domestic jet services should further weaken the friction of distance, thereby accelerating the intensification of the hierarchical nature of intermetropolitan air linkages.

BENJAMIN E. THOMAS—*Climate and Transportation in Interior West Africa*

Rainfall in West Africa affects the navigability of rivers and the passability of dirt roads. Also, temperatures are too high in the adjoining Sahara to justify the operation of bus and truck lines during the torrid summer.

From climatic conditions it might appear that road transportation would be impeded only by summer heat in the desert and summer rain in the Sudan, and that rivers would be navigable only during the period of summer rains. However, summer rain actually begins in the south, spreads northward, and then retreats, so that the pattern of soaked and impassable roads is in almost constant change. Also, there is a great lag in drainage and flood stages on the Niger and the Senegal. The southern tributaries rise in the late summer, while the Middle Niger is still at a low, unnavigable level. The Upper Niger then gradually fills and, several weeks later, flows over rapids and raises the next segment of the Niger. This continues until some parts of the river reach a high level during the dry (winter) season. Water floods the nearby roads, resulting, strangely enough, in usable rivers but impassable roads during the dry season for certain areas.

The complex and changing nature of the transportation network adds to the difficulties of economic development. For this paper, the segments of roads and waterways that are usable in each month have been mapped for French West Africa from field data; explanations of the physical causes of the changing patterns, and the economic effects, are given.

FRANK H. THOMAS—*The Capture Ratio—A Measure of the Relationship between the Railroad and Its Region*

The purpose of this paper is to present by map analysis the relationship between production regions and agricultural traffic originating regions of the Denver and Rio Grande Western Railroad.

The capture ratio is a term used to designate the percentage of the total interregional traffic of a single commodity which is originated by the railroad. A comparison of the capture ratios of the four agricultural commodities originating the largest tonnage on the Rio Grande Railroad reveals significant

differences between the capture ratios of sugar beet, potato, wheat, and peach traffic. Four factors are suggested by the traffic maps to explain the variation in capture ratios: (1) concentration of production; (2) percent actual to potential originating stations; (3) average length of haul; and (4) value per ton.

The index of production concentration, based upon the Lorenz Curve, is high when areally restrictive production conditions are present or low when such conditions are absent, e.g., irrigated versus nonirrigated crops. The percentage of actual to potential originating stations indicates the absence or presence of specialized originating facilities. Commodities with a long average length of haul and low value per ton usually are carried by rail.

EDMUND R. THOMPSON—*Mapping a State-Idea; Malaya, a Case Study*

The conceptual basis for mapping a state-idea is provided by the concept of "field," proposed in the Unified Field Theory of Political Geography. A study of Malaya's state-idea reveals that fields must be recognized as created not only by decision-induced movement, but also by movement induced by ideas themselves, and that it is these latter fields that are most useful in mapping the elements of a state-idea, rather than the field of a resultant decision. In the absence of some method of directly determining an idea's field, the use of indicators often becomes necessary.

Three broad elements of Malaya's state-idea may be recognized and mapped. (1) Malay nationalism, whose maximum possible intensity is mapped by the concentration of Malay-speaking Moslem Malays as expressed by an index of concentration (Malays per square mile \times Malays as a percentage of total population by census district), is limited areally by the extent of modern internal communications as expressed by areas within ten miles of a motor road or railroad. (2) Western democratic ideas are strongest in, and radiate from, areas urbanized and most influenced by the British, as indicated by cities of more than 10,000 that were under British influence for at least 50 years, or by the concentration of literates in English. (3) Intercommunal cooperation, born of political necessity,

will for some time gain greatest acceptance in areas where neither Malays nor Chinese form an absolute majority.

The limits of a state-idea's acceptance should not exceed the effective national territory.

KENNETH THOMPSON—*English Walnuts: The Relocation of a Major California Crop*

Of the many drastic changes in the spatial patterns of crop production in California, few are more drastic than the recent relocation of English walnut production. This important crop ranks next to oranges and peaches as California's most valuable tree crop. Formerly concentrated in the southern counties, the main production centers today are in north-central California.

The foremost reason for the migration is the tremendous urbanization, at the expense of walnut acreage, of the southern walnut-growing districts. The major relevant aspects of urban development are large-scale subdivision, freeway construction, increased draft on underground water supplies, disruption of irrigation and drainage systems, increased tax liabilities, damage from air pollution, and competition from more profitable crops. Another cause of the northward shift is a desire to practice irrigation on a wider and more economic scale than is generally possible in the south. Location in the south was more a historical accident than a reasoned decision. The northern California climate is now generally considered better suited to the crop. The northern regions also provide escape from the older, decadent orchards, afflicted with blight, insect pests, and fungus troubles of various types.

Extensive relocation of a tree crop is unusual, particularly trees that take as long to mature as English walnuts. Orchards represent a heavy investment in capital and time. A grower is reluctant to abandon an established orchard but makes the best of the situation, keeping in production to recover what he can from his expenditure. Besides this inherent tendency to immobility, other factors also work against relocation—the availability of a suitable labor pool and handling, processing, and marketing facilities.

The environmental advantages offered by the northern walnut districts, coupled with

the high land prices that southern orchards command for urban uses, have overcome the potent immobilizing influences. The consequent completeness and celerity with which this tree crop has been relocated speaks eloquently for the dynamism and flexibility of California agriculture.

JACK RICHARD VILLMOW—*Regional Contrasts Within Berlin, Germany*

As a bizonal political area completely surrounded by the Communist-controlled German Democratic Republic, Berlin occupies a position of unusual geographic interest. This former capital of Germany is examined regionally in terms of the distinctive geographic character of (a) the Communist-controlled sector, (b) the frontier zone or "Grenze" between East Berlin and West Berlin, and, (c) the American-British-French controlled sector.

Aerial photographs, surface photographs, and maps are used to point up similarities and differences among these three parts of Berlin. Field experiences during the summers of 1956 and 1958 revealed rapid changes in East Berlin's appearance. Special emphasis is laid upon the significance of East Berlin in the total economy of the German Democratic Republic.

STEPHEN S. VISHER—*Streams*

Streams have such profound significance that their discussion is an appropriate geographic task, which, however, has been neglected by most American geographers. Streams have received only incidental mention in A.A.G. programs or in papers published in the *Annals*.

Indiana has several sorts of streams. Because of its humid climate, permanent and intermittent surface streams are more abundant than in most parts of the world. They have cut conspicuous and locally important valleys in the unglaciated and older glaciated regions. Deforestation, land drainage, the construction of numerous roads, and urbanization have increased runoff and hence flooding, but have decreased the uniformity of stream flow. The erection of many bridges has greatly decreased the barrier effect of streams. Underground streams occur in limestone caverns (for example, Lost River) and

in the numerous beds of gravel and sand that supply many wells and springs. Drainage ditches and pipelines are relatively common; there are tens of thousands of miles of ditches and more than 200,000 miles of drainile. There are also many hundreds of miles of water, sewer, oil, and gas pipelines and many scores of miles of gasoline pipelines.

In addition to present streams, ancient ones have significance locally in the glaciated region for water supplies; in the oil-bearing strata many wells obtain their oil from sands deposited along ancient streams.

No stream is without some effect upon the environment. Illustration of how individual streams affected the development and present status of Indiana is a part of the author's prolonged study of Indiana.

PAUL P. VOURAS—*Ecological Variations in the Villages of Greece*

Greece consists predominantly of village communities. This type of social organization has become firmly established and exerts a great influence on the nation's economic and political development.

Despite the unifying elements—close kinship relations and deep-rooted attachment to the soil—there is a sharp distinction between the hill villages and the plains villages. The distinction is not simply one of altitude. The hill villages are characterized especially by population pressure, susceptibility to political agitators, and physical isolation. The plains villages, on the other hand, are more productive, have greater access to the urban markets, and are less susceptible to radical political agitation.

Since the resource base of the hill villages is often inadequate to provide the growing population with the necessities of life, there has developed a sort of symbiosis with the plains area. The able-bodied men of the hill villages have sought work in the plains to supplement their meager income. As long as nothing interfered with this economic relationship between the hill village and the plain, the hill villagers were successful in earning enough capital to purchase the required materials. However, when this relationship was disrupted during World War II, the economic status of the hill villages became desperate. Despite the efforts of the Greek government

to improve their economic lot, the obstacles of poverty, ignorance, and conservatism still retard their economic growth and cause further political and social problems. What happens in the hill villages will, in large measure, determine the future status and history of Greece.

WILLIAM H. WALLACE—*Recent Trends in Merrimack Valley Manufacturing—The Postwar Era*

The long-time importance of the Merrimack Valley as a center of textile and shoe manufacturing is well known, as is its disastrous decline during the period between the two World Wars. This paper is an examination of recent industrial changes in the Merrimack area.

The postwar period has brought a resumption of trends that began thirty years earlier. The exodus of the textile industry has accelerated; the long-continued decline of cotton manufacturing has now been joined by shutdowns of woolen and worsted mills. Fortunately, shoe manufacturing, the other traditional Merrimack Valley industry, although certainly not "booming," has enjoyed a small expansion during the past decade. Among the growing industries, electrical products manufacturing is easily outstanding, and its rapid expansion suggests a major change in the valley's industrial structure. Unfortunately, in no other industry does expansion compare, even remotely, with that in electronics, and consequently total manufacturing employment in this region has declined by 13 percent (nearly 17,000 jobs) during the 1947-57 period.

The Merrimack Valley towns have not been indifferent to the disintegration of their industrial base. Numerous public and private organizations have made vigorous efforts to capitalize on the advantages of this region, and are participating in the highly competitive struggle to attract new industry. For the future, as in the past, the major resource of the valley is its workers, experienced in industry (though not skilled except in textile and shoe manufacture) and willing to work for wages that are low by comparison with other areas in the Northeast.

HENRY J. WARMAN—*The Effects of Urbanization on Diurnal Temperatures*

Several case studies of diverse sites—Hartford and New Britain in Connecticut; Lowell, Gardner, Pittsfield, Springfield, and Fall River in Massachusetts; and Trenton, New Jersey—are presented. Methods used are described and illustrated.

Isothermal maps, using hundreds of early morning and mid-afternoon temperature readings, have been drawn. The extent and degree of impact on the temperature patterns of soil, hydrologic systems, and vegetation, and of roadways, sewage networks, lighting and heating apparatus, and living and working conditions are explored.

Finally, some possible reciprocal effects of diurnal temperatures and urbanization are suggested, and proposals for utilization of the findings are made. Examples include effects on temperature where neighborhoods are in process of urban renewal, where destruction and construction are involved, and where park land and parking lots are established. Some thoughts are presented on where to build with respect to water bodies, when and where to plow in snowfall areas, and what to do with surplus heat in industrialized areas.

WILLIAM WARNTZ—*Macrogeography and Some Aspects of a Demographic History of the United States, 1790 to 1950*

Macrogeographic maps of population distribution, compiled at the American Geographical Society from microgeographic data of decennial censuses, 1790-1950, make possible testing of long-standing hypotheses concerning spatial expansion of the United State population, movement of the frontier and impact of "unfavorable" physical environment, and effectively occupied national territory.

Certain quasi-equilibrium tendencies in the areal distribution of population are revealed. One example concerns rural densities which at every census have varied directly as the potential of population squared. However, the mathematical factor of proportionality, though a constant geographically at any census, showed a systematic decline through time related to the changing rural proportion. A certain pure number constant of the natural science type emerges when total population, rural segment, and the factor of proportional-

ity are analyzed. The solution can be independent of area or by means of an integration over area, thus providing a measure of effectively settled territory at any census.

The history of the spatial relations of peak of potential, minimum aggregate travel point, and center of gravity of population is discussed.

Three historical periods are defined for the areal population distributions: (1) 1790-1840—establishing the pattern; (2) 1840-1900—westward migration; (3) 1900-1950—increased relative importance of the Eastern Seaboard and appearance of the West Coast peak.

These findings point to the importance of macroscopic first approximations as a way of organizing complex microscopic details.

JOHN W. WEBB—*The Settlement Hierarchy of the Mesabi and Vermilion Ranges, Minnesota*

Most theoretical discussion and empirical investigation concerning the existence of a hierarchy of urban service settlements has been directed toward regions where agriculture forms a background to service provision. On the Mesabi and Vermilion, where mining is the economic base, the hierarchy of service provision is well defined. Ninety distinct nucleated settlements, forming a broken line from Grand Rapids to Ely, can be divided into five distinct population classes. This division can be qualified and reinforced on consideration of criteria relating to morphology, retail and other business, professional services, newspaper publication, schools, and the populations of tributary areas.

Of 53 places with fewer than 140 inhabitants, 49 are *residential*, offering no services. They are associated with one dominant location factor, usually a mine or railway facility.

Of 19 places with 180-550 inhabitants, 15 are *local service centers*, offering basic retail services. They are associated with a mine or railway facility, or are relics of formerly larger places.

Twelve places with 750-2050 inhabitants are *minor service centers*, offering more retail facilities, plus other services. All are early settlements; each is associated with an important group of mines.

Four places with 5000-7000 inhabitants are

intermediate service centers, offering a variety of urban services. They are of early origin and have been located near continuous large-scale mining operations.

Two places, one with 12,000 and the other with 16,000 inhabitants, are *major service centers*, offering a wide variety of services. They had historical primacy, are centrally located, and have been located near continuous massive mining operations.

KEMPTON E. WEBB—*Problems of Urban Food Supply in Brazil*

The purpose of this paper is to analyze the effectiveness and viability of Brazil's food resources as reflected in the actual process of supplying food to consuming centers.

Published figures indicate that agricultural food production is keeping pace with the country's rapid population increase. Such optimism, however, tends to fade as the complicating components of precarious production bases and production techniques, lack of guaranteed markets owing to inadequate transportation facilities, limited credit for the small-scale producer, absence of conservation practices, and speculation are brought into focus.

The basic items of diet consumed in quantity—namely, rice, beans, manioc, maize, sugar, lard, bananas, and cheap cuts of beef—are low in price and generally reflect the population's low income, which is further decimated by a spiralling inflation.

Field studies of Belo Horizonte and Fortaleza have revealed that the source areas of basic foods are usually located hundreds and even thousands of kilometers away from the consuming centers. Perishable foods are generally produced close to the consuming centers. Source centers and the volume of food sent to consuming centers vary widely at different times of the year; they also vary with harvest conditions during the same month. Trucks and trains are the principal carriers of food, but the truck is faster, more dependable, and therefore more desirable.

The recurrent theme that seems to characterize urban food supply in all but the most agriculturally diversified and productive areas of Brazil is the low degree of regularity and standardization of supply currents.

PAUL WHEATLEY—*Geographical Notions of a Chinese Official of the Southern Sung*

This paper offers a conspectus of the geographical knowledge of an official stationed in South China during the Southern Sung dynasty (A.D. 1127–1279), a period when, owing to an unprecedented expansion of maritime trade, the Chinese were acquiring a vast amount of new information relating to the lands of Southeast Asia and the shores of the Indian Ocean. The official whose work is here examined was Chao Ju-kua, sometime Superintendent of Merchant Shipping at Ch'üan-chou, whose views on world geography have been preserved in a handbook of maritime trade compiled in the years immediately prior to 1225. His geography was an amalgam of material culled from earlier Chinese topographical writings fused with a great deal of new information obtained orally from Arab merchants, who at this time enjoyed some degree of extraterritorial privilege in Ch'üan-chou and Canton.

Chao Ju-kua's book, called "Gazetteer of Foreigners," is arranged in two parts. The first consists of descriptions of 53 territories ranging from Japan to Spain; the second comprises a systematic account of the principal foreign products that entered into Chinese trade. Here two aspects of this work are considered. In the first place Chao's geographical concepts are briefly related to the intellectual environment of South China in the thirteenth century, and the accuracy and detail of his observations are assessed under the following regional headings: Southeast Asia, the Indian subcontinent, Southwest Asia, East Africa, and the Mediterranean. In the second place the contribution of Chao Ju-kua to our knowledge of the economic geography of the Indian Ocean at this period is discussed and evaluated with the aid of distribution maps.

WILLIAM W. WINNIE, JR.—*Population Trends in the Caribbean Realm*

By Western Hemisphere standards Caribbean America is densely inhabited. Its average of 16 persons per square kilometer does not approach the much higher densities characteristic of Europe and Asia. The population of 53 million accounts for about 13 percent of the Western Hemisphere total.

The West Indies are more densely settled than the mainland part of the area. Within the islands, there are more people per unit area in the Lesser Antilles than in the Greater Antilles. The mainland average of 11 persons per square kilometer reflects the combination of El Salvador and a few small, densely settled highland areas on the one hand with relatively vast expanses of much more sparsely settled lowlands on the other.

Throughout Caribbean America, population growth is taking place today at the highest rates the world has ever known. From 1950 to 1956, the average annual increase of 2.6 percent for Caribbean America was substantially higher than the corresponding rate for any other major world area except Southwest Asia and the remainder of South America.

The recent and very large increase in the rate of increase is due almost entirely to the decline in mortality which has taken place throughout the area. Fertility has apparently remained approximately constant at very high levels, and migration, where at all significant as a growth factor, has reduced rather than contributed to the high rate of population increase, except in Venezuela and possibly in the Dominican Republic and one or two of the countries adjoining El Salvador.

LOUIS A. WOLFANGER—*Some New Horizons in Soil Conservation and Land Use*

New horizons in soil conservation are appearing in the countryside surrounding our towns and cities, into which our fast-growing population is exploding, as well as in the countryside itself beyond the urban fringe. An illustration of each follows.

In the scramble for space for homes, business enterprises, recreation and other land uses in the urban fringe, land character has been largely ignored; and as usual when Nature is neglected, she is inclined to kick back. The promptness with which she can stall septic systems and return their contents either to the bathroom or to the surface of the ground, or discharge it into drinking water (if the system is imbedded in soils that are ill-drained or that have percolation rates too low for quick intake) is an example of her miffed reaction. This soil factor is now beginning to receive

attention both by real estate developers and by individual householders.

In the rural lands beyond the urban fringe there is a new handwriting on the conservation wall that may forecast a better and more conservative use of our farm and range lands. It calls for a *complete* program of soil and water conservation and the systematic accomplishment of this program before the landowner receives one penny's reward—and this only for practices he would ordinarily not perform. As yet this is only a local incentive program but it has been received with approval. If successful, the policy could set the pattern for the soundest nation-wide, incentive-prompted soil conservation program yet conceived.

M. GORDON WOLMAN and L. M. BRUSH—*Experimental Study of Factors Controlling the Size and Shape of Stream Channels in Coarse Noncohesive Sands*

The size and shape of equilibrium channels in uniform, noncohesive sands, 0.67 mm. and 2.0 mm. in diameter, were studied experimentally in a laboratory flume 52 feet long in which discharge, slope, sediment load, and bed and bank material could be varied independently. For each run a straight trapezoidal channel was molded in the sand and the flume was set at a predetermined slope. Introduction of the discharge was accompanied by widening and aggradation until a stable channel was established. By definition a stable equilibrium existed when channel width, water surface slope, and rate of transport became constant.

Stability of the banks determined channel shape. In the 2.0 mm. sand at a given slope and discharge only one depth was stable. At this depth the flow was just competent to move particles along the channel bed. An increase in discharge produced a wider channel of the same depth; thus transport per unit width remained at a minimum. An apparent "cohesiveness" in the 0.67 mm. sand, however, permitted a 1.5-fold increase in depth above that required to initiate movement of the bed material. Increased transport was associated with the increase in depth.

For a given slope and size of bed material, the discharge per unit width in the laboratory

channels was similar to that computed for ana-branches in braided and other rivers flowing in noncohesive sediments. Despite impressive bank erosion, the laboratory channels only meandered at supercritical flows associated with very steep slopes, conditions not common to most natural rivers.

JAMES R. WRAY and ROBERT S. COLLINS—*Geographical Aspects of Market and Media Information Needed by Buyers of Poster Advertising*

The information-gathering operations of the National Outdoor Advertising Bureau illustrate very well some geographic aspects of market and media information needed by buyers of all advertising.

NOAB assists advertising agencies in servicing advertising campaigns that use poster or painted display media. In doing so, it gathers and processes information about where such advertising services are available. There are two main kinds of information: (a) information needed to consider use of the medium; and (b) information needed to service the contracts and to certify contract fulfillment.

For planning poster campaigns in 1959, NOAB has already distributed to its agencies a four-volume statistical encyclopedia called the "NOAB Buyer's Guide to Poster Advertising." The first two volumes contain a complete alphabetical listing of all poster markets, sizes of showings, and costs. The third volume comprises a geographical or "Area Listing." It lists poster markets and selected costs according to standardized statistical areas; a map of United States statistical areas is included. The fourth volume contains more detailed maps, summary tables, and an alphabetical index to the maps and "Area Listing." The maps show the geographic grid, counties, statistical areas, and poster markets.

So far, the "Buyer's Guide" provides none of the information that agencies need *after* the poster campaign has been placed. The Bureau now contemplates a "Market Phase" of the Guide. It requires maps that define each urban area in terms of land use and identify critical elements of the street pattern and the traffic pattern. The maps would also relate poster advertising facilities, and each advertiser's poster showing, to these patterns.

CHENG-TSU WU—*New York Chinatown*

The Chinese in New York City, despite half a century of residence, remain a distinctive cultural group. The pattern of their distribution is greatly affected by the composition of the population. Their age distribution, sex ratio, and occupation bear peculiar characteristics. The degree of segregation or concentration of the Chinese in New York City was measured, and the correlation between the monthly rent and segregation index was computed.

Chinatown, as analyzed in this study, is not a "ghetto," but a district characterized by the exhibition of Chinese culture. The intensity of the distribution of this Chinese cultural phenomenon was measured and mapped. The role of Chinatown may be viewed as a nodal area for the Chinese in the metropolitan city. The nodality was analyzed in its social, economic, political, and cultural aspects.

Chinatown to the people in New York City other than Chinese is both a sightseeing attraction and a slum area. Any solution for slum clearance in Chinatown confronts difficulties in the maintenance of Chinatown's functions for the Chinese people and in the preservation of Chinese cultural phenomena as a focus of interest in New York City.

In short, if peculiarities in the composition of the Chinese population were eliminated, the Chinese distributional pattern would be changed noticeably, and the nodality of Chinatown to the Chinese people would then gradually diminish. The cultural phenomena of Chinatown, however, would be preserved forever so as to contribute to the tourist industry of New York City.

BOGDAN ZABORSKI—*The Role of the "Development of Surface" in the Description of Relief*

The morphometric analysis of the relief of a region is usually based on the study of relative heights and the steepness of slopes and their frequency. However, there is another method of obtaining mathematical description of the type of relief.

The true geometrical surface area of a region divided by its projected area gives a value which can be called the "development of surface." However, calculation of the true surface area from the data supplied by a large-

scale topographic map involves a complicated procedure. In order to simplify the work we can cover the part of a map that represents a specific region with a dense net of parallel lines and draw profiles along these lines. The relation of the length of the profile line to its projection will reflect its "development." The set of such profiles will illustrate the "development of the surface." For the average, non-mountainous region, the figure obtained for the "development" differs very little from one. Therefore, for practical purposes it is advisable to multiply the figure obtained by 1000.

Morphometric description of nonsurveyed areas can be worked out from the study of profiles obtained by radar aerial surveys. When necessary, "development of surface" can be used together with other morphometric methods in order to obtain a more complete description of the relief.

In delimiting territorial units for morphometric measurements we should try to select small regions that are uniform with regard to the type of relief. It is not recommended to refer morphometric data to squares or other geometric figures or to the units of administration which are delimited regardless of relief.

WILBUR ZELINSKY—*Industrial Dispersion of the American Cities*

Data from the manufacturing censuses of 1939, 1947, and 1954 have been analyzed to determine the absolute and relative growth of industry, measured in terms of both production workers and value added, for urban (10,000+) as opposed to nonurban areas. The 460 Standard Economic Areas of the United States were grouped into six industrial and nine subindustrial regions and also into six population categories based upon size of largest city; manufacturing trends within their urban and nonurban components were studied. For purposes of historical perspective, comparable information is offered for those few cities for which data were published for the entire 1890-1954 period.

Within the two subperiods, trends for 1939-47 were indeterminate, but from 1947 to 1954 there was a decided net national shift outward from the city. On closer scrutiny, however, this movement appears limited to larger metropolitan areas and to the more heavily industrialized SEA's, and, furthermore, represents

a pattern of suburbanization rather than genuine ruralization. Correlation with population data casts doubt as to whether this suburban shift exceeds that of city dwellers during this era of profound metamorphosis for the urban community. Within less urbanized and industrialized SEA's, industrial activity is growing at a decidedly faster rate within cities than outside them. In almost all areas, there are important but perplexing divergences between trends revealed by the two different indices.

Our best answer to the question of whether American industry is dispersing is a highly qualified "perhaps;" a better one depends upon a more adequate area definition of the American city.

LEONARD ZOBLER—*A Proposed Food Resource Efficiency Statement for the United States and Japan*

The following statistic is suggested as a way of making a comparative evaluation of the efficiency with which various countries utilize their total food resource environments:

$$\frac{A'}{A} (y_1 n_1 a_1 + y_2 n_2 a_2 + \dots y_n n_n a_n),$$

in which

A is the total cultivated area,

A' is the adjusted food producing area,

y is the yield relative for each food,

n is the nutrition relative for each food, and

a is the area relative for each food.

Data are presented for the United States and Japan as an illustration of the use of the method. The ratio A'/A indicates the change in a country's cultivated area through the use of noncultivated land, nonland food sources, food imports or exports, etc. The quantity inside the parentheses combines the diverse components that affect food availability.

The computations indicate that Japan uses its food resource environment ten times more efficiently than the United States. The statistic also may be adapted for use as a measure of population pressure and as a means of economizing inputs into agriculture for food production.

REVIEW ARTICLES

THE CITIES OF INDIA AND THEIR PROBLEMS

During the last few years a flood of publications has appeared on various aspects of urbanization in India. Though it is impossible to give a precise index of the increasing attention paid to this field in India in the last few years, an indication of this trend is provided by the fact that an annual social science bibliography for India contained one entry on "cities" in its 1953 issue, whereas it contained 23 such entries four years later.¹

The reason for this increased concern with urbanization seems clear. The census of 1951 revealed an unprecedented growth of towns and cities in India. Urban population, which in 1941 amounted to 13.9 percent of the total population, made up 17.3 percent of a larger population in 1951. Whereas the total population of the Indian Union grew by 13.3 percent in the decade 1941-51, the urban population grew by 34.8 percent in the same period. Moreover, there is every indication that the pace of urban growth is continuing, probably at an increasing rate, and that India will boast in 1961 not 77 cities with populations of 100,000 or more (as she had in 1951), but possibly well over 100 cities of that size.

The growth of urban places in and by itself would be of less concern if it did not produce at the same time a number of social problems which are new and demand constructive solutions. Unemployment in Indian cities is high, especially among educated persons, and this creates serious social and political problems. The growth of cities is due in large part to immigration, the conditions and causes of which are still little understood. Moreover, housing, water supply, and sanitary services are sorely lacking in Indian cities, and the rapid growth of population creates increasing pressures for supplying even minimum facilities in this field. This makes necessary some action in the direction of urban planning in order to better balance short-run and long-run needs. Much of the present growth of cities takes place by the building of shanty-towns, "bastis," which are being established on any piece of land that happens to be available.

¹ UNESCO, Research Centre on the Social Implications of Industrialization in Southern Asia, *Social Science Bibliography, India*, Vol. II (1953), p. 98, and *Social Science Bibliography, India-Pakistan*, Vol. VI (1957), p. 148.

Indian cities, and especially the smaller towns, suffer from a plethora of slums; and general conditions of overcrowding and absence of facilities in urban places in India are perhaps best characterized if we compare urban densities in India with those in other countries.

In 1951 Greater Bombay had a density of 25,579 persons, Ahmedabad, 38,834, and Surat, 58,723 per square mile.² Corresponding densities in Chicago (1939) were 21,093 persons per square mile, but one must bear in mind that in India most residential dwellings are only one-story, whereas many residential dwellings in Chicago are several stories. These figures of population density refer to the overall population and area both of Indian cities and Chicago. More revealing comparisons are possible if we look at densities in specific sections of cities. For example, according to the 1951 census the density in Old Delhi was 136,536 persons per square mile, whereas the corresponding density in New Delhi was 8419 persons per square mile. In Chicago, in 1939, densities in what were designated as blighted areas were 41,307 persons per square mile; in areas designated as "stable" it was 17,989 persons per square mile. In other words, New Delhi had a lower density than what was considered the urban norm for an American city, but Old Delhi—and this includes areas which would be designated as slums, as well as areas not so considered—had a density almost four times as high as a blighted area in an American city. The vast compression of human beings in small spaces in Indian cities becomes even clearer if we consider that in three of the 18 wards of Old Delhi densities of over 400,000 persons per square mile were observed and that another four wards showed densities of over 275,000 persons per square mile. Only five wards out of the 18 had densities of less than 100,000 persons per square mile.³

² R. K. Patil and K. M. Talati, "Trends in Urbanisation of Surat City: A Case Study," in Indian Economic Association, *Papers Read at the 39th Annual Conference of the I. E. A.*, 1958 (Bombay, 1958), p. 79.

³ The densities for Delhi have been computed by the author. The densities for Chicago are taken from W. H. Ludlow, "Urban Densities and Their Costs: An Exploration into the Economics of Population Densities and Urban Patterns," in Coleman Woodbury, ed., *Urban Redevelopment: Problems and Practices* (Chicago: University of Chicago Press, 1953), p. 213.

The immediate impetus for the study of urban conditions in India came from several quarters. In 1952 UNESCO sponsored a comparative study of immigration to South Asian cities in several countries of the ECAFE region. These studies were published in a volume entitled *The Social Implications of Industrialization and Urbanization*, and two of the five studies in this volume relate to Indian cities (Bombay and Delhi).⁴ At approximately the same time the Indian Sociological Association, and somewhat later the Indian Economic Association, made the discussion of urbanization processes topics of their annual meetings. Finally the Research Programmes Committee of the Planning Commission sponsored studies of the socioeconomic conditions prevailing in some 20 major cities of India. Though each research group charged with the analysis of any one city had a fairly high degree of freedom to follow its own method of investigation, many of these studies were patterned after the urban surveys which had been done during the war and immediate postwar period by the Gokhale Institute at Poona.⁵ The surveys produced under the auspices of the Research Programmes Committee present, without doubt, the greatest amount of actual data which are becoming available on socioeconomic conditions in Indian cities.

It is a pity, however, that the researchers who have undertaken these studies have displayed little imagination and have kept strictly to preconceived patterns of research. Hence,

ecological problems are left unexplored, little attention is given to the relation between a city and its immediate hinterland, and the spatial distributions within a city, in general, and within the larger city region are completely neglected. This is unfortunate, because it not only robs us of a good deal of geographical knowledge of Indian cities which might easily have been collected, it also deprives these surveys of a good deal of their usefulness for urban planning, a task which eventually will become indispensable. So far, three of these surveys have become available in book form, among which the one on Poona is the largest, whereas the two others on Hyderabad-Secunderabad and Baroda, though containing some interesting data, show no genuine originality.⁶ A brief version of the report on Jamshedpur is also available, so far only in the form of a journal article, but the full version in book form will soon become available. The remaining volumes should appear within the next two or three years. When the whole series is published, it will constitute the most extensive collection of data on various social and economic characteristics—family composition, number and composition of immigrants, earnings, employment and unemployment, housing conditions and associated facilities, and general economic conditions of the urban population—of the city population in any Asian country.

Although the urban studies undertaken under the auspices of the Research Programmes Committee constitute perhaps the most massive survey on urban socioeconomic conditions in India, they do not exhaust the whole body of urban research in India. Basic to all of it are a number of "inventory" studies of recent growth patterns and the spatial distribution of Indian cities, which have been undertaken by different persons at approximately the same time and which have been made as a result of the very extensive details

⁴ UNESCO, Research Centre on the Social Implications of Industrialization in Southern Asia, *The Social Implications of Industrialization and Urbanization* (Calcutta: Research Centre on the Social Implications of Industrialization in Southern Asia, 1956). See esp. the papers by P. N. Prabhu, "Bombay: A Study of the Social Effects of Urbanization," pp. 49-106, and M. B. Deshmukh, "Delhi: A Study of Floating Migration," pp. 143-226. See also a general study on urbanization in southern Asia, Philip M. Hauser, ed., *Urbanization in Asia and the Far East* (Calcutta: Research Centre on the Social Implications of Industrialization in Southern Asia, 1957).

⁵ D. R. Gadgil, *Poona: A Socio-Economic Survey*, Part I (Poona: Gokhale Institute of Politics and Economics, 1945), and Part II (Poona: Gokhale Institute of Politics and Economics, 1952); R. G. Kakade, *The Socio-Economic Survey of Weaving Communities in Sholapur* (Poona: Gokhale Institute of Politics and Economics, 1947); N. V. Sovani, *The Social Survey of Kolhapur City*, Part I (Poona: Gokhale Institute of Politics and Economics, 1948), Parts II and III (Poona: Gokhale Institute of Politics and Economics, 1951-52).

⁶ N. V. Sovani, D. P. Apte, and R. G. Pendse, *Poona: A Re-Survey* (Poona: Gokhale Institute of Politics and Economics, 1956), xx and 555 pp. Maps, tables, index. \$3.50; S. Kesava Iyengar, *A Socio-Economic Survey of Hyderabad-Secunderabad City Area* (Hyderabad: Government Press, 1957), xx and 390 pp. Maps, charts, tables. \$2.25; H. C. Malkani, *A Socio-Economic Survey of Baroda City* (Baroda: Sadhana Press, 1958), xi and 179 pp. Map, tables. Rs.5.00; B. R. Misra, "Socio-Economic Survey of Jamshedpur," *Economic Papers*, Vol. II (November, 1957), pp. 1-26.

on the demography of Indian cities published in Volume I, Part II-A of the *Census of India, 1951*.⁷ Some of these studies, notably the papers by G. S. Ghurye, V. Nath, and a number of contributors to the symposium on "Urban Development Trends in India," sponsored by the Indian Economic Association, deal with growth patterns of urban India during the last 50 years.⁸ Though these papers present a historical depth, they do not carry the discussion of urbanization trends back of the early censuses, and only one recent article, by R. I. Crane, contains also an analysis of urban patterns in India before the British conquest.⁹ The papers by Ghurye, Nath, and some of the contributors to the Indian Economic Association's symposium (notably S. B. Bagal, A. Bose, and N. V. Sovani) contain a number of useful statistical distributions, e.g., by size classes, by differential growth rates according to size classes, and preliminary classifications of cities by function.¹⁰ Sovani also shows that at least since 1921 Indian cities have conformed to the rank-size rule.

In contrast to these papers, a recent essay by Gananathan and a thesis by Amrit Lal emphasize spatial relations, though these works also concentrate on functional distinctions.¹¹ This is especially true of Lal's work which, however, uses a rather peculiar statis-

tical measure to arrive at a functional classification of cities. In addition to these works, which deal with the spatial relations of Indian cities on a nation-wide basis, several regional studies also are of interest.¹² Outstanding among them are E. Ahmad's study of towns in Uttar Pradesh, and the article by the same author and O. H. K. Spate on cities in the Gangetic plain. Additional regional studies which deserve attention are M. Guha's study of urban centers in West Bengal, R. V. Joshi's study of urban centers in Western India, V. A. Janaki's study of Kerala, B. Sinha's essay on Orissa, and V. V. Ramanandham and Y. Venkatesawarlu's paper on Andhra.

The contrasts and similarities in urban patterns discussed in these papers are of special interest, since they all are written by geographers and deal with regions which topographically, socially, and economically present great differences. Compare, for example, the narrow, densely populated area of Kerala with the vast plain in the Ganges valley, the broken, often inhospitable, dry country of western India, and the relatively sparsely populated and city-poor countryside of Orissa. Contrast all these with the lush tropical region of West Bengal, dominated by the vast urban agglomeration of Calcutta at one end and the growing mass of urban centers of the Damodar Valley-Asansol region at the other end. Consider further the wide economic differences prevailing in these various regions: for example, the relatively wealthier, more highly commercialized economy of western India, especially Gujarat, as contrasted with the backward agricultural countryside of Orissa. These differences, in addition to differences in social life, caste structure, and general character of the population, impose

⁷ India, Registrar General, *Census of India, 1951*, Vol. I, Part II-A, "Demographic Tables" (Delhi: Manager of Publications, 1955), pp. 61-97.

⁸ G. S. Ghurye, "Cities of India," *Sociological Bulletin*, Vol. II, No. 1 (May, 1953), pp. 47-71; V. Nath, "Urbanization in India with Special Reference to the Growth of Cities," in United Nations, *Proceedings of the World Population Conference, 1954*, Vol. II (New York, 1955), pp. 843-54; various authors, "Urban Development Trends in India," Indian Economic Association, *op. cit.*, pp. 3-114.

⁹ Robert I. Crane, "Urbanism in India," *American Journal of Sociology*, Vol. LX, No. 5 (March, 1955), pp. 107-114.

¹⁰ S. B. Bagal, "Trends of Urbanization and Rural-Urban Migration in India, 1901-51," in Indian Economic Association, *op. cit.*, pp. 15-29; Ashish Bose, "The Pace of Urbanization in India," *Ibid.*, pp. 30-42; N. V. Sovani, "Trend of Urbanisation in India," *Ibid.*, pp. 107-114.

¹¹ V. S. Gananathan, "Distribution of Urban Settlements in India," in *Proceedings of the 17th International Geographical Congress* (Washington, 1952), pp. 742-745; Amrit Lal, "Some Characteristics of Indian Cities of over 100,000 Inhabitants in 1951 with Special Reference to Their Occupational Structure and Functional Specialization" (unpublished Ph.D. thesis, Department of Geography, Indiana University, 1958).

¹² E. Ahmad, "Origin and Evolution of the Towns of Uttar Pradesh," *Geographical Outlook*, Vol. I (January, 1956), pp. 38-58; O. H. K. Spate and E. Ahmad, "Five Cities of the Gangetic Plain," *Geographical Review*, Vol. XL (1950), pp. 260-78; Meera Guha, "Urban Regions of West Bengal," *Geographical Review of India*, Vol. XIX, No. 3 (September, 1957), pp. 31-44; R. V. Joshi, "Urban Structure in Western India," *Ibid.*, Vol. XVIII, No. 1 (March, 1956), pp. 7-19; V. A. Janaki, "A Functional Classification of Urban Settlements of Kerala," *Journal of the M. S. University of Baroda*, Vol. III (1954), pp. 79-104; V. V. Ramanandham and Y. Venkatesawarlu, "Economic Aspects of Town Formation in Andhra Pradesh," *Indian Geographical Journal*, Vol. XXXII, Nos. 3-4 (July-December, 1957), pp. 63-85 and B. Sinha, "Urban Geography of Orissa," *Ibid.*, pp. 86-94.

conditions which will show up also in the distribution and function of urban places in different parts of India. And just as it is of significance to determine spatial and functional patterns of urban distributions for India as a whole, it is also of importance to make these studies for the various regions into which India is divided, precisely because of the different topographical, social, economic, and climatic conditions prevailing in these different regions.

Not only do regional studies of urban distributions not exist as yet for the major regions of India, the situation with regard to descriptive or analytical accounts of individual cities is even less satisfactory. We have already referred to the already published (and the forthcoming) socioeconomic studies of major Indian cities, but these surveys are limited in general scope and leave out of consideration many variables which are of special interest to the geographer. There have appeared, however, in the last few years a few studies, written from the sociological or the geographical viewpoint which do deal with what are intended to be rather exhaustive surveys of Indian cities. The three most notable ones, as judged by their size, are the works by Venkatarayappa on Bangalore,¹³ by Bopegamage on Delhi,¹⁴ and by Singh on Banaras.¹⁵

The first two of these books are primarily sociological studies, and the last is a straightforward urban geography. In any over-all evaluation of the three books, there is no question but that Singh's work on Banaras is by far the best and most useful. Singh uses a well-established method, his procedures are sure and forceful, the questions he asks and the data he assembles follow an established pattern, and the over-all result is a clear picture of spatial relations of such significant distributions as population, economic activities, public institutions, neighborhoods, etc., in

the city of Banaras and its environs. Since Singh's study is approached from the geographical viewpoint, he pays attention to physical site characteristics. He is concerned not only with the major existing transport arteries but also with questions concerning drainage, surface configuration, and the impact of different parts of the *Umland* upon the present morphology of the city and its potentials for expansion. Hence, when Singh, in the last chapter of his book, turns to an evaluation of various schemes for the planning and improvement of Banaras, he has laid the groundwork for evaluating the feasibility and appropriateness of such developments in terms not only of the economic and social requirements of Banaras, but also in terms of its physical facilities. As we shall see later, the much less adequate methodology employed by Venkatarayappa and Bopegamage, does not lead to results of this kind.

A general survey of the chapters in Singh's work and the other two books, shows great similarity. After a brief historical introduction, there is in each book a chapter on the physical setting, followed by one on the cultural landscape, population, the economic functions of the city, and some additional chapters on public utilities, housing, traffic, and the prospects of urban planning and developments. Only the study on Banaras has a section relating the city to its *Umland*, and only the study on Banaras has a chapter discussing the topographical and morphological features of the city.

In spite of the outward similarities in general structure of the three books, the geographical study is superior to the one labeled "social ecology" and the one labeled "sociology." In part this may be due to the skill of the writer, but in large measure it is due to the uncertainty of method employed by sociologists as contrasted with geographers. The ecological approach, as it is displayed by the books of Venkatarayappa and Bopegamage consists mainly in a listing of the major functional zones within a city without explanation of the flow of persons and commodities that take place between them and without relating them to the topographical or internal morphological features of the city. A city is merely an assemblage of one or more business centers, industrial quarters, residential neighborhoods, etc. Though general account is taken of the

¹³ K. N. Venkatarayappa, *Bangalore: A Socio-Economic Study* (Bombay: University of Bombay Press, 1957), vi and 157 pp. Maps, illustrations, tables, index, bibliography. Rs. 16.50.

¹⁴ A. Bopegamage, *Delhi: A Study in Urban Sociology* (Bombay: University of Bombay Press, 1957), xii and 235 pp. Maps, charts, tables, bibliography, index. Rs. 21.50.

¹⁵ R. L. Singh, *Banaras: A Study in Urban Geography* (Banaras: Nand Kishore & Bros., 1955), xv and 184 pp. Maps, illustrations, charts, tables, bibliography, index. Rs. 12.50.

historical or locational factors which determine the precise situation of these city regions with respect to one another, this fact is not further explored, and when it comes to suggestions for planning, proposals are made which in terms of actual feasibility are absolutely fantastic, simply because a number of simple factors pertaining to the physical environment—e.g., drainage characteristics or levels of underground water—are omitted.

The socioecological approach suffers not only from this shortcoming, it also suffers from the absence of a well-rounded set of questions raised at the beginning of the investigation and the lack of tentative hypotheses concerning the functional orientation of a city. What kind of a city is Bangalore? How important are its administrative as against its manufacturing and distributive functions? Or take the Delhi case. How important is the function of Greater Delhi as the capital of India, as against its function as the major distributive center in northwest India? Whereas up to 1911 Delhi was a provincial capital of secondary importance, it became a colonial capital in that year. In 1947 it became the capital of a large independent country, and at the same time, with the loss of Lahore to Pakistan, it became the major trading, banking, and transport center in northwest India. It is now the third largest city of India and by far the largest inland city of that country. How have these features—the increasing significance of governmental functions, the increasing importance of transport and communications, the increasing weight as a distributive center, and, last but not least, the growing importance of industry—affected Delhi? What has been the impact of these same factors, in somewhat diminished degree, in Bangalore? What impact have these factors had on the surrounding areas—of special interest in Delhi, since some of the suburbs of Delhi are located in Uttar Pradesh and Punjab—and, most important, what trends have been observable in the spatial distribution of these functions within each city? These are most interesting questions which are treated only very superficially in the books by Bopegamage and Venkatarayappa and which would have deserved extensive and careful research.

The comparison of these three books, all three of which emanated from doctoral dissertations, seems to point out that, in India at

least, standard geographical methods of research are superior to socioecological ones and that the points investigated and the answers obtained are more satisfactorily handled if a researcher pursues "urban geography" rather than "social ecology." Further shortcomings of the books on Bangalore and Delhi also should be mentioned. There happen to exist a number of subsidiary studies on both cities which could have been used with advantage. This is especially true of Delhi. Above all, there had been published, in 1956, an Interim Plan for Greater Delhi, which contains a large amount of extremely useful material. Similarly, on Bangalore there has appeared a suggestive paper by N. P. Gist, which treats of social ecology in that city in a rather ingenious fashion.¹⁶ These, and a number of other government reports, have been left unexploited by the authors of the two socioecological city studies. In a way the publication of the book on Delhi was a bit premature, since in the last year, as a consequence of the work on the Greater Delhi Development Plan by the Town Planning Organization of the Ministry of Health, a number of additional useful studies have appeared. This is especially true of a pamphlet issued under the auspices of the National Council of Applied Economic Research on commodity flows in Delhi.¹⁷ This pamphlet breaks some new ground as concerns the locational study of Indian cities. It poses the questions: What major commodities come into Delhi, how are they distributed within Delhi, what institutions and what spatial patterns are employed in getting them distributed, and how is trade in such major commodities as fuels, foods, and textiles carried out in its social and spatial aspects in an Indian city? The report by the National Council exhibits data on these points, supported by graphs in which the major flows and intensity of flows are mapped and in which the main distributional points are indicated.

It might be mentioned that the National Council pamphlet, as well as the books by

¹⁶ India, Ministry of Health, *Interim General Plan for Greater Delhi* (Delhi: Manager of Publications, 1956); Noel P. Gist, "Ecology of Bangalore, India: An East-West Comparison," *Modern Review*, Vol. CI, No. 5 (May, 1957), pp. 337-64.

¹⁷ National Council of Applied Economic Research, *Commodity Disposition Survey in Delhi* (Bombay: Asia Publishing House, 1959), vii and 48 pp. Maps, tables. Rs. 7.25.

Bopegamage and Venkatarayappa contain quite a few maps, some of which are designed to provide new information. Yet, the sheer technique of map making could have been vastly improved. The lettering is poor, and in cases in which maps are colored, the colors are not well chosen. More important, the maps are drawn with little imagination, major points are often omitted, and the maps sometimes contain too much and sometimes too little information. There is no question but that Indian researchers in fields related to geography could profit greatly from some technical aid in the design and execution of maps.

The works which have been discussed so far almost all deal with a set of urban centers or a single city and are concerned with a multitude of social, economic, or demographic problems in the city or cities analyzed. A large part of the literature relating to urbanism in India, however, is directed toward certain single special aspects, and we shall now turn briefly to an evaluation of these other writings. The most widely discussed problems are those of labor conditions in Indian cities and of unemployment, especially in urban areas. On this second topic an extensive series of articles was published in the *Indian Journal of Commerce*, in its December, 1954, and March, 1955, issues. These articles suffered from a lack of adequate data; they were speculative rather than factual, and even in analysis they became superseded soon by a concise and well designed essay on this topic by W. Malenbaum.¹⁸ In the meantime the National Sample Survey has collected a considerable amount of data on unemployment in urban areas all over India and has published them in several statistically extensive publications.¹⁹ Also, other government offices have collected information on this problem, which

is taking on increasing importance in the minds of Indian planners. The latest and most up-to-date study is a recent pamphlet produced by the National Employment Service of the Ministry of Labour.²⁰ This last study presents a summary view of the problem, but for details one must turn to the various publications of the National Sample Survey, as well as some other surveys which have been made at the local level, for example, in Lucknow, Baroda, and Nagpur.²¹ Among all these reports, the National Sample Survey's report on employment and unemployment in Calcutta²² is a model, in its coverage, in the occupational classification of the labor force, and in the over-all presentation of data. It is to be hoped that this publication (which is as yet available only in mimeographed form) will become a standard according to which other surveys of urban employment and unemployment may be patterned.

Next to the question of employment, that of urban labor conditions is most burning. The problem of wages and general labor conditions was of such concern to the Indian government that it undertook as one of its earliest postwar survey tasks a far-flung investigation of family budgets of urban working-class families. These studies were published, one small pamphlet for each major city, and though they are not of outstanding interest from a methodological viewpoint, they do contain many data on differences in consumption patterns among the lower classes in many urban centers of India (and Pakistan). It should be noted that coverage of north Indian cities is much more complete than those in south India.²³

²⁰ India, National Employment Service, *Unemployment in Urban Areas* (New Delhi: Manager of Publications, 1959).

²¹ B. Singh, *A Report on Unemployment in the City of Lucknow* (Lucknow: Lucknow University Press, 1955); Y. V. Kolhatkar and C. T. Shah, "A Survey of Unemployment and Underemployment in the City of Baroda," *Journal of the M.S. University of Baroda*, Vol. V, No. 1 (March, 1956), pp. 75-121; Madhya Pradesh, Directorate of Economics and Statistics, *Survey of Educated Unemployed in Nagpur City* (Nagpur, 1956).

²² India, National Sample Survey, *Report on Sample Survey of Employment in Calcutta: 1953* (Calcutta: Indian Statistical Institute, 1956), 74 pp. and 38 unpaginated tables. Mimeographed. n.p.

²³ India, Ministry of Labour, *Report on an Enquiry into the Family Budgets of Workers in Delhi* (Delhi: Manager of Publications, 1954), is one of the studies. Others cover the following major cities: Ajmer,

¹⁸ See the symposium on "Urban Unemployment in India," in which participated A. C. Shukla, K. P. Sundharam, K. B. Dangayach, P. K. Ghosh, B. N. Misra, P. Brahmamand, and M. L. Mishra, *Indian Journal of Commerce*, Vol. VII, No. 28 (December, 1954), pp. 1-62, and Vol. VIII, No. 29 (March, 1955), pp. 1-10; also Wilfred Malenbaum, "Urban Unemployment in India," *Pacific Affairs*, Vol. XXX, No. 2 (June, 1957), pp. 138-50.

¹⁹ India, National Sample Survey, *Special Report on the Survey of Persons on the Live Register of the Delhi Employment Exchange* (New Delhi: Manager of Publications, 1954); *Report on Preliminary Survey of Urban Unemployment in September 1953* (Delhi: Manager of Publications, 1956).

Of greater interest than these studies of family budgets are analytical studies of labor conditions and the labor supply in Indian cities. Apart from the study by Prahū on Bombay (cited in footnote 4 above), there are two valuable studies on the urban cotton mill workers in west Indian centers, one with a historical slant by M. D. Morris and another comparing features of the factory and non-factory populations by R. D. Lambert.²⁴ These two studies by Americans may be supplemented by (1) a study on the Bombay textile mill labor force written from the social service standpoint and (2) a book on the Bombay cotton mill workers which attempts to provide a comprehensive and well-rounded picture of all aspects of the life and work cycle of the Bombay mill workers.²⁵ But in analytical power these remain far behind the essays by Morris and Lambert. It may be worth reporting also that attention has been given not only to the working class in Bombay but also to the socioeconomic conditions of the middle and upper classes.²⁶ These studies, together with the surveys of the workers, provide a fairly well-rounded survey of social and economic conditions among all social classes in Bombay, especially those associated with the textile industry.

None of the other industrial cities has been surveyed as extensively as Bombay during the last few years, and the Bombay data will have to be compared with those produced for other

cities by the urban surveys in process under the auspices of the Research Programmes Committee (see footnote 6). However, Mr. V. Agnihotri, an employee of the Uttar Pradesh Labour Department, has published several articles on the conditions of the working class in Kanpur, which constitute a fairly comprehensive survey of living and working conditions of the laboring classes in this city.²⁷

In part, labor conditions in Indian cities are dependent upon migratory patterns. It has been estimated that 40 percent of the urban labor force consists of migrants, and, although there exist no precise data on this point, the proportion of migrants increases as skill of the laborer decreases. This means that the most poorly paid jobs in most Indian cities are filled by migrants, or, in other words, that immigrants normally attach themselves to the lower fringe of the urban social structure. Unfortunately, there is as yet little known about migratory patterns in Indian cities. Some interesting facts, especially on the lowest earners in an Indian city, have been brought to light in a recent socioeconomic survey of the slums of Delhi, which follows in its methodology the traditional pattern set by the Gokhale Institute and the studies sponsored by the Research Programmes Committee of the Planning Commission (see footnotes 5 and 6).²⁸ In addition, the studies done under the auspices of the Research Programmes Committee stress the analysis of migration and the conditions of recent migratory workers. In Delhi, the number of recent immigrants is rather larger than in most other Indian cities, chiefly because almost 500,000 refugees settled there after partition. However, the refugees constitute a special case, and few urban centers face the refugee problem as a more or less permanent one. Calcutta is a major exception, because of its proximity to East Pakistan.

More important in the long run than the immigration of refugees is the migration of non-refugees to Indian cities. The patterns of

Ahmedabad, Bombay, Dehra-Dun, Gauhati, Howrah, Jamshedpur, Jharia, Jubbulpur, Kanpur, Kharagpur, Ludhiana, Sholapur. In addition some reports on cost of living in minor cities have also been published. All are located in north India and a few (Lahore, Karachi, Sialkot) in Pakistan.

²⁴ M. D. Morris, "The Supply of Labour to the Bombay Cotton Textile Industry, 1854-1951," *Indian Economic Journal*, Vol. I, No. 2 (October, 1953), pp. 138-52; Richard D. Lambert, "Factory Workers and the Non-Factory Population in Poona," *Journal of Asian Studies*, Vol. XVIII, No. 1 (November, 1958), pp. 21-42.

²⁵ A. N. Biraj, "Textile Labour in Bombay City," *Indian Journal of Social Work*, Vol. XIV, No. 2 (September, 1953), pp. 168-77; A. G. Gokhale, *The Bombay Cotton Mill Worker* (Bombay: Millowners Association, 1957), 126 pp. No price given.

²⁶ S. K. Kadri, "An Inquiry into the Socio-Economic Position of Employers in the City of Bombay," *Journal of the University of Bombay, Hist. Econ. and Sociol. Series*, Vol. XXI, No. 4 (January, 1953), pp. 91-93; C. S. Patil, "A Socio-Economic Survey of the Middle Class in Bombay," *ibid.*, Vol. XXV, No. 49 (July, 1956), pp. 20-24.

²⁷ Among the more interesting papers by V. Agnihotri are the following: "Poverty among Factory Workers in Kanpur," *Labour Bulletin, Uttar Pradesh*, Vol. XIV, No. 10 (October, 1954), pp. 13-19; "Employment and Education among the Blind in Kanpur," *ibid.*, Vol. XV, No. 1 (January, 1955), pp. 16-19; and *Housing Conditions of Factory Workers in Kanpur* (Lucknow: Fine Press, 1954), 63 pp.

²⁸ Bharat Sevak Samaj, *Delhi Pradesh, Slums of Old Delhi* (Delhi: Atma Ram & Sons, 1958), 239 pp. Charts, tables, illustrations. Rs. 5.00.

this migration are, as yet, little understood. A few pilot surveys have been done, among them the study by Deshmukh, referred to earlier in this paper (footnote 4). Deshmukh traced the migratory pattern of workers from central India to Delhi. Only a few similar studies exist, among them one on north India by E. Eames, two studies by N. P. Gist on migratory patterns in southern India, and one general and rather superficial survey on overall migratory pattern by P. K. Rao.²⁹ Although these articles present some interesting facts on a rather limited scale, the methodology for the study of the social and economic impact of cityward migration has been exhibited best in a study dealing with the migration of displaced persons in the urban areas of Bombay State, done by the National Sample Survey.³⁰ The prestige of the National Sample Survey is so great that we may expect several other parallel studies in the near future using the techniques proposed there; it is to be hoped that these techniques will also be applied to the study of non-refugee migrants.

The study of migrants evokes two further aspects of urbanism which we must discuss before concluding this survey of research on Indian cities. The first is the relation between cities and the rural areas, especially the hinterland or *Umland* of a city. The second is the problem of town planning as a measure which will preserve cities from developing the characteristic urban sprawl which has proven too costly to remove and so uneconomical in Western countries.

As has already been pointed out, the study of urban-rural relations is as yet little explored. The various socioecological studies, and the socioeconomic surveys pay scarcely any atten-

tion to areas outside the city limits. The only study reviewed in this essay which pays explicit attention to the relationships between a city and its *Umland* is Singh's book on Banaras. However, some attention to the problem is given in a few transportation studies, notably one by the National Council of Applied Economic Research on goods transport by road in the Delhi region, and an essay by M. Guha on transport in the Calcutta region.³¹ Some attention to this problem is also given in an essay by A. Vasanta. Although he is concerned primarily with describing methods of delimiting the area of urban concentration, in the course of this task he wrestles with the problem of urban boundaries and the relations between the nucleus within and the region outside the boundary. Finally, there exist several studies of towns of secondary importance which are within the wider reaches of a larger city, which exhibit a dependency relationship to the larger city, and which dominate the countryside immediately surrounding them. Among the abler studies of this kind should be mentioned an essay by R. L. Singh on Mirzapur, a town within the wider *Umland* of Banaras, a study by A. K. Sen on Bankura, West Bengal, and hence within the orbit of Calcutta; a dissertation by H. F. Hirt on Aligarh, which lies within the region of Delhi; and the study by Singh on Gorakhpur, which tends to hold a position marginal to the Banaras *Umland* and yet constitutes an urban center showing little difference in life patterns from those of a large village.³² Gorakhpur is a railway center

²⁹ E. Eames, "Some Aspects of Urban Migration from a Village in North Central India," *Eastern Anthropologist*, Vol. VIII, No. 1 (September-November, 1954), pp. 13-26; Noel P. Gist, "Selective Migration in Urban South India," in United Nations, *Proceedings of the World Population Conference, 1954*, Vol. II (New York, 1955), pp. 811-22; and "Selective Migration in South India," *Sociological Bulletin*, Vol. IV, No. 2 (September, 1955), pp. 147-60; also P. K. Rao, "Urban Pull in India" in International Institute of Differing Civilizations, *Record of the 27th Meeting Held in Florence* (Brussels, 1952), pp. 217-25.

³⁰ India, National Sample Survey, *Report on the Sample Survey of Displaced Persons in the Urban Areas of the Bombay State* (Delhi: Manager of Publications, 1957), viii and 98 pp. Tables. Rs. 2.00.

³¹ National Council of Applied Economic Research, *Some Aspects of Goods Transport by Road in the Delhi Region* (Bombay: Asia Publishing House, 1959); Meera Guha, "Transport in and around Calcutta," *Geographical Review of India*, Vol. VII (1955), pp. 4-8.

³² A. Vasanta, "A Method to Delimit Areas of Urban Concentration," *Indian Geographical Journal*, Vol. XXXII, Nos. 3-4 (July-December, 1957), pp. 95-100; R. L. Singh, "Mirzapur, A Study in Urban Geography," *Geographical Outlook*, Vol. I, No. 1 (January, 1956), pp. 16-27; and "Gorakhpur, a Study in Urban Morphology," *National Geographical Journal of India*, Vol. I (September, 1953), pp. 1-10; A. K. Sen, "Bankura, a Study of the Cultural Landscape of an Urban Area," *Geographical Review of India*, Vol. XVIII, No. 1 (March, 1956), pp. 9-14; and H. F. Hirt, "Aligarh, Uttar Pradesh, A Geography of Urban Growth" (unpublished Ph.D. dissertation, Syracuse University, 1955).

and a market town, but it has few of the characteristics of a genuine city and in spite of its size of around 150,000 inhabitants, it clearly exhibits many transitional features from rural to urban conditions. These studies present analyses of the morphological and socioeconomic aspects of the transition from rural to urban distributions. They are supplemented by an essay by Srinivas, which deals with the cultural dimension and contrast in value structure accompanying this transition from rural to urban settlement patterns.³³ The persistence of rural settlement types in what are essentially urban environments have, of course, been observed often. A. Bopegamage has devoted an article to describing a village within the metropolitan area of Delhi, and B. F. Hoselitz has stressed the village-like character of many neighborhoods of Indian cities.³⁴

The heterogeneity in Indian cities is one of the chief factors demanding the early application of rehabilitation and development plans. Urban planning involves a multiplicity of problems, many of which are as yet little explored and understood in India. There is still confusion and doubt on urban land policy, zoning, and local tax and improvement legislation; above all, there is lack of understanding in many places of the basic requirements and conditions of urban planning. Whatever progress has been made in the last few years is described briefly and superficially in an essay by J. Wood in *Land Economics*, and, with special reference to the administrative problems, by N. K. Gandhi in a paper on the construction of new towns.³⁵ The delicate problem of urban land policies in India has been described in a recent paper of C. C. Desai, and O. H. Koenigsberger has presented a magnificent essay on plans for new towns in

India.³⁶ This essay also contains good maps which clearly show the problems faced by urban planners in India.

As for the plans themselves, little has been published as yet, except from the purely architectural viewpoint. The famous new capital of Chandigarh has not been described in detail, nor has the less famous, but perhaps better planned, new capital of Orissa, Bhubaneswar.³⁷ There exist apparently only two proposals of development plans for large cities, the Interim General Plan for Greater Delhi, which is in process of revision, and an early rather sketchy plan for Bombay which was proposed in 1948.³⁸ Nevertheless, the need for urban planning is increasingly recognized, and it is likely that the revised development plan for Greater Delhi, which may be published late in 1959, will constitute a model according to which further urban plans in India may be developed.³⁹

In spite of the scarcity of resources, present trends of urban growth in India make town and city planning imperative at this time, if serious future costs are to be minimized. Increased emphasis on the study of urban centers, not merely in their socioeconomic, but also in their topographical and morphological aspects, is a precondition of adequate town planning. Although this survey of the literature suggests that more is now known than ever before concerning Indian urbanization, India is still far from possessing adequate inventories of its urban centers, their functions, their populations, and their problems.

³⁶ C. C. Desai, "Urban Land Policies in India," in United Nations, *Urban Land Problems and Policies* (New York, 1953), pp. 76-82; O. H. Koenigsberger, "New Towns in India," *Town Planning Review*, Vol. XXIII, No. 2 (July, 1952), pp. 94-132.

³⁷ A rather superficial account of Chandigarh is contained in M. Fry and J. B. Drew, "Chandigarh and Development in India," *Asian Review*, Vol. XLI (1955), pp. 110-25.

³⁸ M. V. Modak and A. Mayer, *Outlines of a Master Plan for Greater Bombay* (Bombay, 1948); also see the publication by the Indian Ministry of Health cited in footnote 16.

³⁹ Britton Harris, "Urbanization Policy in India" (a paper delivered before the Regional Science Association, Chicago, December, 1958). Scheduled for publication in *Papers and Proceedings*, Regional Science Association, Vol. Five.

³³ M. N. Srinivas, "The Industrialization and Urbanization of Rural Areas," *Sociological Bulletin*, Vol. V, No. 2 (September, 1956), pp. 79-88.

³⁴ A. Bopegamage, "A Village within a Metropolitan Area," *Sociological Bulletin*, Vol. V, No. 2 (September, 1956), pp. 102-10; Bert F. Hoselitz, "Urbanization and Town Planning in India," *Confluence*, Vol. VII, No. 2 (Summer, 1958), pp. 115-27.

³⁵ J. Wood, "Development of Urban and Regional Planning in India," *Land Economics*, Vol. XXXIV, No. 4 (November, 1958), pp. 310-15; N. K. Gandhi, "New Towns Construction in India," *Quarterly Journal of the Local Self-Government Institute*, Vol. XVIII (October, 1957), pp. 435-45.

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SPATIAL STRUCTURE OF THE ECONOMY: I

What determines the spatial arrangement (structure, pattern, or location) of economic activity? Attention has been given to this question recently in books by Isard, Dunn, Greenhut, Ponsard, Lösch, and Boustedt and Ranz, and in a number of articles.¹ These are the subjects of this and subsequent review articles.

A cursory examination of this literature reveals that the subject matter of these studies varies widely. A few workers have dealt with the individual decision-maker, e.g., studies of the spatial connections of households; some have dealt with problems of the locations of individual firms; whereas others have approached the question at more aggregated levels. A number of these workers have dealt with the location structures of meaningful

aggregates of firms, e.g., the petroleum industry of the United States, and others have dealt with urban, regional, national, and world aggregates of activities.

The four levels of work just discussed merge rather nicely with classifications adopted by writers who orient their work toward significant, theoretical, policy, and/or practical questions. Work on residential site selection, for example, is at the level of the individual decision-maker, work on the selection of factory locations and/or sites for retail business is at the level of the individual firm, and a number of transportation and planning problems fit into the two aggregative classes. Theoretical works on the determinants of spatial patterns are available at each level of subject matter, although theoretical works which attempt to merge geographic patterns with economic equilibrium are largely at the aggregated levels.

The glance at the literature also reveals contrasts in the apparatus through which researchers erect and explore their problems. In recent years growth of the general field of activity analysis, especially linear programming, has had a marked influence upon research. Recent workers have made use of programming; earlier workers structured problems in other ways. This has not been a matter of changing the approach in order to be fashionable. Certain very real benefits may be obtained through the use of these tools. Many problems that were intractable ten years ago are now very close to being trivial, and many new problems have been recognized. Programming is newer than the A-bomb. This reviewer agrees with Flood² that it is possibly of comparable importance.

In Parts II and III of this review (to appear in later issues of these *Annals*) the impact of programming approaches on analysis will be given special attention. Unavoidably, this treatment means dealing with a literature other than that concerned directly with spatial problems, and, since programming is couched in mathematical terms, it also means that certain mathematical statements will be made.

² Merrill M. Flood, review of Andrew Vazsonyis, *Scientific Programming in Business and Industry*, in *American Scientist*, Vol. 46 (December, 1958), p. 358A.

¹ Walter Isard, *Location and Space Economy* (Cambridge: Technology Press of the Massachusetts Institute of Technology; New York: John Wiley and Sons, 1956). xiii and 350 pages. Illustrations, index. \$8.75.

Edgar S. Dunn, Jr., *The Location of Agricultural Production* (Gainesville: University of Florida Press, 1954). vii and 115 pp. Illustrations, index. Paper, \$2.50; cloth, \$3.50.

Melvin L. Greenhut, *Plant Location in Theory and Practice: The Economics of Space* (Chapel Hill: The University of North Carolina Press, 1956). xiii and 338 pp. Illustrations, bibliography, index. \$7.50.

Claude Ponsard, *Économie et Espace: Essai d'intégration du facteur spatial dans l'analyse économique*, *Observation économique*, Collection publiée sous la direction de André Piatier, Vol. VIII (Paris: Sedes, 1955). xv and 467 pp. Illustrations, bibliography. 2,000 fr.

August Lösch, *The Economics of Location*, translated from the second revised edition by William H. Woglom with the assistance of Wolfgang F. Stolper (New Haven: Yale University Press, 1954). xxviii and 520 pp. Illustrations, index. \$7.50. The German title is *Die räumliche Ordnung der Wirtschaft* (Jena: Gustav Fischer, 1943).

Olaf Boustedt and Herbert Ranz, *Regionale Struktur- und Wirtschaftsforschung, Aufgaben und Methoden* (Bremen: Walter Dorn, 1957). xviii and 218 pp. Bibliography. DM 16.

Two books that might have been reviewed with these works were called to the author's attention too late for inclusion. The first, recommended by Professor Torsten Hägerstrand, is Ejler Alkjaer's *Erhvervslokalitets Beliggenhedsproblemer* (København: Einar Harcks, 1953). viii and 95 pp. This book would be of special interest to those concerned with problems of the location of retail business. The second, recommended by Professor Brian J. L. Berry, is Hans Ulrich Meyer-Lindemann's *Typologie der Theorien des Industriestandortes* (Bremen: Walter Dorn, 1951). xv and 235 pp.

SIX RECENT BOOKS

Six important books dealing with spatial questions appeared between 1954 and 1957. The English translation of Lösch's *The Economics of Location* appeared in 1954. (Here 1954 is regarded as the date of appearance since the 1943 edition in German has not been generally available in this country.) Dunn's book on agriculture was also published in 1954, and the books by Isard and Greenhut were published in 1956. In 1955 a book by Ponsard was published in France, and the book by Boustedt and Ranz was published in Germany in 1957.

Professor Isard's many publications on spatial problems are well known to geographers, economists, and planners. Core parts of his book, *Location and Space Economy*, are re-statements of journal articles published during the late 1940's and early 1950's. In the book these statements are augmented and linked into an integrated view of location process. This presentation accomplishes several things: (1) it provides a summary statement of the results of earlier workers who treated the general location problem, (2) it gives a brief glimpse of some empirical regularities which suggest the existence of spatial order and, thus, processes, (3) it develops the concept of transport inputs, (4) it uses the device of substitution analysis and the concept of transport inputs to add a spatial dimension to economic analysis, and (5) it outlines a statement of the total space economy through a mathematical model and through graphic synthesis. Of these, the overriding accomplishments are placing spatial problems within the substitution analysis framework of traditional economics, and in showing how a landscape can be constructed from theory.

Isard begins by posing the problem, reviewing general works by Lösch, Palander, Predöhl, and others, and then showing certain empirical regularities which are associated with the space economy. These topics are respectively a chapter each, and together they pose the problem for analysis in the book as a whole. The empirical regularities discussed include the rank-size rule and the diminution of interactions with distance.

Isard's analytic discussion begins with his identification of the concept of the transport input—a weight-distance unit—which can be thought of in the same way that capital, labor,

and other industry inputs are considered. A cost may be attached to the transport input, and the firm compares these costs with costs associated with other types of inputs and the value of outputs. The location problem becomes the problem of "substitutions" among alternate costs and output revenues; that is, costs and outputs are compared (substituted for one another) until net profits are maximized. This is a major contribution of the book—the location problem is placed in the metric of the transport input and analyzed as a substitution problem.

Isard gives his discussion generality by showing how transport inputs may be considered when selecting among market areas, supply areas, products, alternate transport inputs, and so on. He shows how agglomeration may be treated as a problem in substitution and how agricultural and urban rents may be involved in the substitution process. The relations between location and trade theory are also examined.

Isard's final chapters deal with general situations. In a chapter couched in mathematical terms he sets forth some aspects of a general theory. His final chapter is a graphic integration of his previous analysis. This graphic synthesis serves as a summary and shows the conservative character of Isard's approach. The approach does not yield radical answers; neither does it destroy or downgrade any conclusions which have been available, however intuitive, heretofore.

Dunn has provided a statement for agriculture which emphasizes rent as the determining agent in location decisions. *The Location of Agricultural Production* is the outgrowth of his Ph.D. dissertation written at Harvard in 1951, a time when Isard was at Harvard. Thus it is not surprising that Dunn's approach to agriculture is quite similar to that of Isard. Dunn builds chiefly on Thünen's early study,³ Lösch's work, and a well-known work of Brinkmann,⁴ but he extends his analysis considerably beyond that of these earlier writers. In the first half of his book he develops an explanation for the spatial structure of agriculture, assuming a plain that is homogeneous

³ Johann Heinrich von Thünen, *Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie* (Hamburg, 1826).

⁴ Theodor Brinkmann, *Economics of the Farm Business*, translated by E. T. Benedict (Berkeley: University of California Press, 1935).

in natural resources, and that transport structures, population, and certain other variables are not subject to change. The discussion carries through several chapters which set forth the general problem and the manner in which the distance factor influences the spatial distribution of rents and, thus, land-use patterns. The equilibrium of land-use patterns is considered, and, finally, general statements are given bearing on the multiple product firm, multiple markets, and the varying production possibilities of land. In the last section of his book Professor Dunn relaxes some of the assumptions used in his static analysis. Processes of change in the regional economy as induced by population shifts are also reviewed in a somewhat general way.

This analysis represents a marked advance over much of the previous work in this field. Dunn's statement is somewhat more incisive than Lösch's, for example, since it contains an explicit distance function which recognizes possibilities for variations in transportation rates among commodities. Dunn's analysis of rent is more direct than Brinkmann's analysis, and his argument is superior to Thünen's in generality and consideration of boundary conditions. On the other hand, Dunn's analysis does not extend very far beyond an analysis of static equilibrium at the industry level. Discussions at the level of the firm and the discussion of dynamic factors are cursory although provocative in places. Perhaps rents could have been more closely connected with flows, and perhaps the analysis of the general ordering of markets and crop areas could have been more penetrating. Nevertheless, there is no question that Dunn's work represents a significant step over and above previous literature.

Greenhut's book, *Plant Location in Theory and in Practice: The Economics of Space*, is aimed at the particular problem of the location of industrial plants and incorporates a set of empirical studies of plant location factors. In these ways, Greenhut's book is somewhat like that of Yaseen,⁵ but Greenhut's penetrating attention to the plant location problem led him to consideration of cases of locational interdependence, discriminatory price systems, and like features of imperfect competition that, for the most part, are

skimmed over in works written to assist industry decision-makers with location problems. His major contribution is chiefly in his interdependence statements and his attempt to gear the site location of the firm into the theory of the firm.

In the first part of his book Greenhut provides a review of major aspects of location theory and develops a summary statement which is put forward as a tentative location theory. This is followed by a detailed consideration of several profit determinants—transportation and processing costs, product demand, revenue-increasing factors, and "personal factors." He then presents his empirical studies of eight firms, ranging from a DDT manufacturing establishment to a peanut processing plant, and provides some general support for his theory. He emphasizes that in each case only a few of the location determinants were recognized, and he also stresses the "personal factor" in the decision process. In the last portion of the volume, Greenhut reconsiders the theoretical statements of the first two sections and the empirical materials of his third section. This yields a rather brief general statement couched in both verbal and symbolic terms, which is intended as an outline of a theory incorporating the results of his empirical studies.

From the point of view of concepts Greenhut's book is very superior to previous studies which have dealt specifically with the plant location problem from an engineering point of view. On the other hand, he has failed to give us the breadth or originality of Isard's work and anything other than impressionistic notes toward a general theory. This reviewer views Greenhut's empirical studies with considerable skepticism. The author seems aware of the difficulties of empirical work. Perhaps this is the reason why his empirical observations are not integrated closely into the final portion of the book. The types of cases selected and the analytical methods applied weaken the empirical portion, although some interesting insights are given.

Ponsard's *Economie et Espace* provides a complete and penetrating review of much of the available material in the location field. Although published before either Isard or Greenhut, Ponsard makes extensive reference to the articles of these writers and, essentially, anticipates the appearance of their

⁵Leonard C. Yaseen, *Plant Location* (New York: Institute for Business Planning, Inc., 1955).

books. Unlike Greenhut, Isard, or Dunn, Ponsard recognizes some of the work in the geographical literature as well as some of the newer work on efficient transportation flows, spatial equilibrium, and activity analysis (subjects of later parts of this essay). Isard refers to some of these approaches in his footnotes and recognizes their tremendous implications for problems of spatial structure, but both Dunn and Greenhut ignore them.

Ponsard's volume is divided into two "books," four parts, and fourteen sections. The first and larger "book" deals with the micro- and macro-economics of location—roughly, discussions at the level of the individual firm and at levels of aggregations of firms, regional aggregations, and urban aggregations. The second and smaller "book" deals with the equilibrium of the decision-maker, the local community, the state, and the world community. Traditionally, discussions of decision-makers have been at the level of the household (worker-consumer) and the firm. As Ponsard's discussion is somewhat broader than the traditional discussion, it is here that he makes his original contribution.

Ponsard's book claims in the title that it is an integration. This is hardly true. It is an exhaustive recapitulation of works on location, together with some general remarks on large-scale aspects of the problem. As a review of the literature, the book is unequaled. Ponsard gives us a penetrating and complete recapitulation of the available literature, much of which is difficult to come by. Certainly Ponsard's book will be used as a reference many times. Perhaps it is too much to ask for a really thorough integration. Ponsard's original discussion of decision-makers is cursory, but it is a first approach to interesting problems.

August Lösch's volume, *The Economics of Location*, has been widely acclaimed as one of the more important books of the decade. It differs somewhat from others in the field in that it deals with what Lösch thinks a spatially ordered society should be, rather than with an explanation of what exists. Thus, he is concerned chiefly with location as a problem in efficient production and with constructing location systems yielding efficient production and distribution. The work is divided into four divisions: (1) location problems, (2) economic regions, (3) trade

problems, and (4) examples. Lösch makes at least three major contributions.

First, he provides the first general statement of location equilibrium. That is, he has written out a set of equations displaying all locations, boundaries, and production—the location system. The equations are straightforward, but it is not completely clear how this system relates to other portions of Lösch's work. Beckmann has pointed out that the equilibrium conditions contain no explicit reference to the price system and supply and demand relations.⁶ He also notes: "... it remains somewhat obscure how the various principles interact, fail to conflict with each other, and indeed succeed to produce equilibrium." Isard (pages 44-48) also reviews Lösch's equilibrium system. Isard notes that Lösch fails to treat the relationships between the optimum location for production and consumption and thus limits himself to several major sectors of the basic economy. These objections aside, Lösch's system remains a pioneering first attempt to investigate the existence of a system of spatial arrangements.

Lösch's well-known model of a hexagonal lattice of distribution and production locations is essential to his equilibrium statement and is another major contribution of his volume. The argument by Lösch is well known. He postulates a continuous distribution of population on a homogeneous plain and asks, What will be the distribution of producing places for this population? The answer to this question is achieved by analyzing the possible shapes of regions, location of production points, and possible sizes of market areas. The result is a complex system of hexagons resulting in an ordered arrangement of cities and transportation routes. The idea of a system of cities having hexagon-shaped trading areas is not new, having been presented by W. Christaller some years earlier.⁷ Christaller considered several systems on the verbal level, but Lösch spells the derivation of several systems and presents patterns resulting from a rotation of the hexagon systems. Lösch's conditions of general equilibrium discussed pre-

⁶ Martin Beckmann, "Some Reflections on Lösch's Theory of Location," *Papers and Proceedings, Regional Science Association*, Vol. 1 (1955), pp. N-1 through N-9.

⁷ Walther Christaller, *Die zentralen Orte in Süddeutschland* (Jena: Gustav Fischer, 1933).

vously, such as the notion that areas of supply, production, and sales must be as small as possible, flow directly from this elegant system.

Lösch's third major contribution is his presentation of empirical information. Here is a wealth of otherwise widely scattered information, organized according to the theme of the book with great insight and with illuminating comments. Much of the material is from the United States and will be of interest to workers here for this reason. On the other hand, there is much literature from other places, especially Germany, which may not be known to researchers in the United States and is of interest for that reason. Lösch's attitude toward empirical information is extremely interesting. He rejects the notion of comparing such information with theory to judge if the theory is correct. "No! Comparison now has to be drawn no longer to test the theory, but to test reality! Now it must be determined whether reality is rational." (Page 363.) Elsewhere, however, Lösch states that his empirical data demonstrate how strong are the forces of spatial order. Examples range from locations of production and towns through considerations of market areas and price levels in space. The empirical materials are highly suggestive, but variable in convincingness. Materials on the spacing of towns, for example, seem to tell us only that large towns are farther apart than small towns. Is this evidence of regularity? Is this evidence of "strong forces of order"?

In a review, one can only skim over the major contributions of Lösch and cannot properly reveal the richness of Lösch's discussion. There is much that is original and provocative, such as the notion of price waves to which Lösch gives much attention. So far as this reviewer knows, this is a new idea with Lösch, and it certainly is an idea which should be further explored.

How may the book be summarized? It is relatively complete, since it covers problems of spatial structure from the level of the individual farm (with a glance at households) through regional and international systems. It also considers the problem of spatial equilibrium. It is rich in insight, but it is spotty. In the review of Dunn's book, for example, it was mentioned that Lösch's discussion of agriculture lacks depth because of failure to

focus on transportation rates differentiated among products. In another instance, although his system of urban centers and networks of supply areas is elegant and incisive, his assumption of a homogeneous plain begs the question of whether his is even a reasonable first approximation. Also, the discussion of associated transportation routes seems unconvincing. He notes, for example, that the areas around major places should be divided into twelve sectors, six with relatively few settlements, six with many settlements. He then postulates the existence of transportation routes along the edges of the sectors. He nowhere notes how the transportation routes of major systems are interconnected; and by principles noted elsewhere in his book, it is easy to see that the transportation routes should be displaced into the sectors with dense settlements.

Boustead's and Ranz's *Regionale Struktur- und Wirtschaftsforschung, Aufgaben und Methoden* is similar to the other books. It is a direct approach to explanations of patterns of spatial arrangements and it contains a survey, integration, and synthesis of previous ideas. Like the other books it is motivated by ideas flowing from earlier workers. Despite these similarities, it is quite different from the others. In much of the book, the authors are concerned with methods of making regional studies; thus, stress is on operations within a regional framework. Problems are stated and treated as regional problems throughout the book, whereas in other books the regional characteristics of the problems are in most cases rather implicit. A portion of the book deals with economic models and, again, the regional emphasis is very strong. The models discussed are those which are operable at the regional level.

The book is divided into three parts. The first is used to state the objectives of regional research and some general statistical problems in regional work. The second part discusses the role and methods of research on regional structure. The final part covers regional economic research.

The first part is a short statement of the nature of regional science (*Regionalforschung*) and aspects of the statistical requirements of the science. The primary problem of spatial science (*Raumforschung*) is the development of fundamental laws of spa-

tial organization. It covers the totality of all factors and their mutual relations in space. It is synthetic since it uses spatial analysis to summarize the findings of other disciplines (including geography). Its objective is fundamental, and its concept has abstract contents. Its practical application is mostly in planning.

The authors view statistical problems chiefly as problems of obtaining data and combining them into effective summary measures to display some regional characteristics. They stress problems of the sizes of statistical units, data collection, and the like. The authors are not unaware of problems of carrying on with statistics through problem-solving operations and discuss briefly the applicability of tests of significance to regional data, but for the most part the idea of statistics as used in this volume is the idea of obtaining and ordering a mass of data bearing on a problem.

The second part of the book continues the discussion of research on regional structures. It treats problems of delimiting spatial units, using the traditional concepts of homogeneous and functional areas, and then treats problems of arranging spatial units into types. The discussion is well organized and competently given in general statements, as well as well-selected examples. The discussion of homogeneous spatial units ranges from a discussion of physiographic regions through cultural, economic, and agricultural regions. Examples range in location from Brazil and Canada to the Netherlands, and include recent work done in the United States on state economic areas and other systems of economic areas suggested by Bogue. The discussion of functional units is concerned largely with the metropolitan landscape and work on urban agglomerations. The only exception is a short discussion of transportation districts in Germany. For the most part, then, the idea of a functional area is essentially equivalent to the idea of a nodal region. Again, examples are given from many areas, from the Scandinavian countries to the United States.

The discussion of classification problems is quite limited. The general problem is discussed, and types of economic communities, social communities, and cities are treated. Only a few examples are given and, in the case of the types of the cities in the United States where a great deal of the work has

been done, the authors' references are rather skimpy. Throughout the book the authors attempt to compare approaches and give judgments as to their value. In the case of the arrangement of spatial units into groups, for example, there is a four-paragraph discussion of the methods of making up typal arrays. Not much can be said in four paragraphs, but the authors are able to stress the increasing importance of the method and certain of its problems. The authors also point out some of the difficulties of using random samples to obtain data for many small areas.

The final section of the book deals with regional economic research and is the largest section. It covers some of the traditional problems of economics on a regional level, including levels of the operation of the economy and money flows. These topics are first discussed in a general way; then, the final part of the section reviews research. There is a brief discussion of problems of regional growth. The larger part of the discussion is based on rather crude models of regional flows and interregional input-output analysis. The latter is treated grossly and uncritically.

The book is extremely well organized, it is easy to read, and the authors have achieved a survey of a large amount of material. The book is advanced in the sense that regional problems are discussed in general and a knowledge of the field is required in order to interpret the general propositions. The book is not statistical in the sense that mathematical symbols and problems appear. Nonetheless, a considerable knowledge of statistical methods of inference is needed in order to interpret certain of the statements. The authors make several incisive comments on random methods of data gathering, for example, and one needs to know what this is about. In another case, the authors comment on variance versus regression models in the delimitation of regions. Since characteristics of such models are not described, acquaintance with them is presumed. It is easy to criticize lack of depth in a book that covers a large amount of material. This reviewer noted especially the rather shallow treatment given to problems of regional grouping and classification in the light of methods available to handle these problems. Much is not covered in the final section on economic models. Even the discussion of input-output analysis is skimpy.

THE SIX BOOKS

What do these six books represent? Certainly they evidence a continued interest by economists in location problems. Whether they represent, in the span of time they cover, a relatively greater increase in attention to location problems than had previously been the case is a question very difficult to answer. In examining the books, one is quite aware of the long history of interest by economists in location questions.

If there are implications in these books for traditional economics, they probably concern introducing location questions via substitution analysis into the analysis of the firm. This is a procedure identified earlier but emphasized strongly for the first time by Isard. Evidence of interest along this line is given by the recent paper by Moses, which criticizes Isard for his failure to consider U-shaped cost curves.⁸ Moses shows that this refinement can be made and moves the location problem closer to traditional economic analysis.

Valavanis recognizes Lösch's notions on the arrangement of towns and market and supply areas as a concept of major consequence for economists, but he points out that there is no analogy to this concept in traditional economics.⁹ Consequently, it is hard to see how this concept could be embraced by traditional economics. As noted before, this concept is basic to Lösch's general mathematical system and accounts for the set of conditions which Lösch attempts to meet in stating his general system. Will this relatively unfamiliar concept have any notable impact on economics? By definition, it could hardly have an effect on traditional economics.

Economists are not the only ones who have followed this literature with interest. What is its consequence for workers in other fields, such as geography? This reviewer doubts if the books by Dunn, Isard, Ponsard, and Greenhut will excite many in geography. These books are written from the standpoint of economics and have as a major objective the placing of location considerations within the sphere of traditional economics. Books

that fly more familiar flags for the geographer are those by Lösch and by Boustedt and Ranz. Certainly Lösch treats many situations for which there are direct analogues in geography. Notably, Lösch's constructs on rural and urban interrelations, economic boundaries, and regional systems all have analogues in geographic work. Boustedt and Ranz emphasize the solution of regional problems for which there also are direct analogues in geography, but since much of the work in their volume is available in the English-language literature, their contribution is more in terms of providing a one-volume collection than in development of new concepts.

Nevertheless, Isard, Ponsard, Greenhut, and Dunn should not be dismissed too quickly. These writers have attempted to incorporate location decisions within the traditional economics. This is not quite the same thing as saying that they bring geographic insights to the field of economics, and it is certainly not the same thing as saying that they bring economic insights to the field of geography. But each does this: they show how economic insights can be used to construct patterns which, in turn, may also be interpreted by geographic insights. This is especially true of Isard's concluding chapter in which he constructs a landscape using ideas developed in previous chapters of his book; here is the urban and rural scene constructed exclusively from location theory. What is equally important is that this landscape is constructed without violating a single notion from economics or from geography. This is extremely suggestive of the mutual relations between geographic and economic forces. Perhaps a major difference between Isard and Lösch is that Lösch has identified some of these mutual relations in greater degree than Isard, but Lösch has broken in some respects from traditional economics in order to identify these insights.

Must geographers break with or augment some of their traditional insights to embrace economic realities? Could a book be written to bring economic considerations into geography? A book has yet to be written which would do for geography what Isard has attempted for economics. This would require an exposition of economic ideas, rather than an assumption of them, as Isard has done.

⁸ Leon M. Moses, "Location and the Theory of Production," *Quarterly Journal of Economics*, Vol. 72 (February, 1958), pp. 259-72.

⁹ Stefan Valavanis, "Lösch on Location," *American Economic Review*, Vol. 45 (September, 1955), pp. 637-44.

STIMULATION OF INTEREST

This reviewer is tempted to say that one major result of these works, especially Isard's book, has been the stimulation of new and increased interest in geographic problems from a point of view that uses concepts from both economics and geography. There is a good bit of evidence for this assertion. In 1954, approximately 60 persons attended the business meeting of the Regional Science Association in Detroit, and the association was formally organized under that name. There have been annual meetings of the association since that date and the association now has approximately 1200 members. Papers presented at its meetings are published in its *Papers and Proceedings*, and four volumes have appeared. In addition, the Institute of Regional Science at the University of Pennsyl-

vania began publishing the *Journal of Regional Science* in 1958, only the first issue of which is available. These organizations and their publications certainly evidence a strong interest in problems of spatial arrangements. Persons in many professions are members of the Regional Science Association, with economists having the strongest representation. Since meetings of that organization have been with the American Economic Association and like organizations, papers presented are largely by economists. For these reasons, results have been chiefly the bringing of economic insights to bear on problems long of interest to geographers. For the same reasons, the interpretation of results chiefly is in economic terms.

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